INDIANAPOLIS POWER & LIGHT COMPANY

PETERSBURG STATION UNITS 1-4
HARDING STREET STATION UNIT 7

ENVIRONMENTAL CONTROL PLAN FOR COMPLIANCE WITH U.S. ENVIRONMENTAL PROTECTION AGENCY'S MATS RULE

SL-011196
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Prepared by

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ABBREVIATIONS AND ACRONYMS

Abbreviation or Acronym	Explanation
AACE	Association for Advancement of Cost Engineering
acfm	actual cubic feet per minute
ACI	activated carbon injection
AHGO	air heater gas outlet
AQCS	air quality control system
AR	as received
BACT	Best Available Control Technology
Big Five Units	Petersburg Units 1-4 and Harding Street Unit 7
BOP	balance-of-plant
Btu	British thermal unit
CEMS	continuous emission monitoring system
CF	capacity factor
CFD modeling	computational fluid dynamic modeling
CO	carbon monoxide
CPM	condensable particulate matter
CPMS	Continuous parameter monitoring system
DOE	U.S. Department of Energy
dscf	dry square cubic foot
DSI	Dry sorbent injection (see "SI" below)
EGUs	Electric utility steam generating units
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ESP	electrostatic precipitator
FGD	flue gas desulfurization
FPM	filterable particulate matter
HAP	Hazardous air pollutant
HCl	hydrochloric acid
HFPS	high-frequency power supplies
Hg	mercury
H_2O	water
H_2SO_4	sulfuric acid
HHV	higher heating value
hp	horsepower
hr	hour
ID	induced draft
in. w.c.	inches water column

Sargent & Lundy LLC

ABBREVIATIONS AND ACRONYMS

Abbreviation or Acronym	Explanation
in. w.g.	inches water gauge
lb	pound
LEE	Low-emitting EGU
LOI	loss on ignition
MACRS	Modified Accelerated Cost Recovery System
MACT	Maximum Achievable Control Technology
MATS	Mercury and Air Toxics Standards Rule
MCR	maximum continuous rating
MIGI rapper	magnetic impulse gravity impact rapper
MMBtu	million British thermal unit
MW	megawatt
MWh	megawatt-hour
NO_X	nitrogen oxides
NPV	net present value
NPVRR	net present value of revenue requirements
O&M	operations and maintenance
PAC	powdered activated carbon
PM	Particulate matter
ppm	parts per million
ppmv	parts per million volume
ppmd	parts per million dry
psia	pounds per square inch absolute
psig	pounds per square inch gauge
RATA	Relative Accuracy Test Audit
RDE	rigid discharge electrode
SBS	Sodium bi-sulfate
SCR	selective catalytic reduction
SI	sorbent injection (see "DSI" below)[1]
SNCR	selective non-catalytic reduction

[1] In this report, the term *sorbent injection* (SI) refers to injections of a solution or dry powder to react with SO_3 in the flue gas. The industry commonly uses the term *dry sorbent injection* (DSI) to refer to this technology.

ABBREVIATIONS AND ACRONYMS

Abbreviation or Acronym	Explanation
SO_2	sulfur dioxide
SO_3	sulfur trioxide
TR set	transformer rectifier set
UBC	unburned carbon
US$	U.S. dollars
wacfm	wet actual cubic feet per minute

EXECUTIVE SUMMARY

On April 16, 2012, the U.S. Environmental Protection Agency (EPA) published in the *Federal Register* a final rule regulating hazardous air pollutant (HAP) emissions from coal- and oil-fired electric utility steam generating units (EGUs) to be effective from April 16, 2012 with compliance required by April 16, 2015, with potential for a one-year extension granted by the State permitting agency. The rule, referred to as the Mercury and Air Toxics Standards Rule (MATS Rule or Utility MACT Rule) requires coal- and oil-fired EGUs to meet hazardous air pollutant (HAP) emission standards reflecting the application of the maximum achievable control technology (MACT). The rule includes emission limits for mercury (Hg), non-Hg metals, and acid gases that could have a significant impact on Indianapolis Power & Light Company's (IPL) coal-fired power plants.

In early 2011, Sargent & Lundy, L.L.C. (S&L) reviewed the impact of the proposed MATS Rule on the IPL's coal-fired EGUs. The results of that review, as summarized in S&L's report SL-010701, concluded that the larger IPL units (Petersburg Units 1-4 and Harding Street Unit 7) would require baghouse additions to reliably comply with the proposed emission limits. The final rule published in 2012 contained some significant changes from the 2011 draft rule. For example, unlike the PM emission limit in the proposed rule, which included both filterable particulate matter (FPM) and condensable particulate matter (CPM), the final rule regulates only FPM emissions. The final rule also includes slightly different non-Hg HAP metals emission limits, different monitoring requirements, and revised emissions-averaging provisions. The rule does not allow system averaging, requiring instead averaging emissions on a site-by-site basis; therefore, Petersburg and Harding Street must be considered separately when averaging emissions.

Based on the projected Hg and hydrogen chloride (HCl) levels in the fuel, the differences between the proposed and final rule potentially will allow for IPL's Eagle Valley Unit 6 and Harding Street Units 5 and 6 to reliably meet the emission limits if the generation capacity factor is limited. The cost estimates for these units were provided to IPL for consideration as part of its resource planning. This report focuses on the "Big Five" units, which are Petersburg Units 1-4 and Harding Street Unit 7.

To develop this environmental control plan for the Big Five Units, S&L reviewed a number of compliance options, including fuel management, enhancements or upgrades to the existing electrostatic precipitators (ESPs), installing baghouses, as well as installing activated carbon injection (ACI) and sorbent injection (SI).[2] Compliance options were evaluated based on continued operation of the existing wet flue gas desulfurization (FGD) control systems, which have proven to provide some PM and Hg removal benefits. The objectives of the recommended environmental control plan are to achieve: (1) emissions compliance, (2) generation reliability, and (3) a cost-effective plan.

Although the MATS Rule regulates HCl, FPM, and Hg emissions, the Hg content in the fuel is one of the primary factors to consider in selecting a control plan that can meet the MATS emission limits. As part of an overall strategy to minimize the fuel costs, IPL historically has purchased fuel from several coal mines in southwestern Indiana. Quarterly fuel samples collected during the past five years indicate that the fuel Hg content has varied between 4 lbs/TBtu and 14 lbs/TBtu, depending on which mine is supplying the fuel. To develop future emissions projections and establish the control plan, the Hg content for the future as-fired coal to Petersburg Station was established at 11.2 lbs/TBtu, based on five years of historical Hg content data. This value represents the maximum Hg content that would be expected in the coal mix over a 90-day time period.

The historical value is based on using the maximum Hg content from the quarterly fuel samples for each mine and creating a station average by using the actual distribution of the fuel sourcing from the various mines. To mitigate the impact from variations in the Hg content and the sourcing distribution, S&L recommends that IPL demonstrate MATS compliance by station averaging at the Petersburg Station. However, since only one unit will be considered at Harding Street Station, station averaging does not apply. Although using the station emission averaging reduces the Hg emission limit from 1.2 lbs/TBtu based on a 30-day rolling average to 1.0 lbs/TBtu based on a 90-day rolling average, given the Hg content variation between mines and within a give mine, the increased averaging period reduces the risk that the as-delivered Hg content will exceed the projected Hg content used to develop the control plan.

To assist in developing the control plan, emissions testing was conducted in March 2012. Hg, FPM, and HCl emissions were tested at Petersburg Unit 2 and Harding Street Unit 7 to characterize the existing equipment performance and to evaluate the impacts of ACI and SI control technology. The testing used a fuel with Hg content

[2] In this report, the term *sorbent injection* (SI) refers to injections of a solution or dry powder to react with SO_3 in the flue gas. The industry

of 8 lbs/TBtu. The results of this testing, combined with other historical test data, were used to project performance of the existing equipment on all five units, including the impact of alternative fuels, in order to develop a MATS control plan for Hg, FPM, acid gases, and non-Hg HAP metals.

Based on an evaluation of the test data available for the existing equipment performance and on the projected performance for the equipment enhancements or baghouse additions, implementation of the options listed in Table ES-1 would provide compliance at Petersburg Station with the MATS Rule. For each of these options, the existing ESPs remain in service except for the ESP at Petersburg Unit 2. ACI and SI systems are also required on Units 1-4 and enhancements are necessary on all of the ESPs that would remain in service. Table ES-1 identifies the projected station average emission values and provides net present value revenue requirements (NPVRR) of the projected capital, operating (including fuel cost differential), and recurring periodic costs for each option.

Table ES-1. Acceptable Technologies to Achieve MATS Emission Compliance at Petersburg

Option	Maximum and Average Coal Hg Content (lb/TBtu)	Units with Baghouses	NPVRR ($Million)	NPVRR Difference (%)	Hg Emission with Max Hg Coal & No Units in Outage and (lb/TBtu)	Hg Emission with Ave Hg Coal & One Units in Outage and (lb/TBtu)	FPM Emission (lb/MMBtu)	HCl Emission (lb/MMBtu)
1	11.2/9.0	P2 & P3	1054	Base	0.87	0.81	0.017	<0.002
2	11.2/9.0	P2 &P4	1081	3%	0.90	0.86	0.018	<0.002
3	11.2/9.0	P3 & P4	1119	6%	0.76	0.69	0.017	<0.002
4	11.2/9.0	P2, P3, & P4	1144	9%	0.66	0.56	0.014	<0.002
5	9.0/6.5	P2	1259	19%	0.90	0.71	0.019	<0.002
6	8.0/5.5	None	1364	29%	0.87	0.6	0.021	<0.002

These options were developed considering fuel flexibility to accommodate the wide range of fuels available in southern Indiana. If baghouses are not installed, the ESPs cannot reliably meet the emission limits, irrespective of whether ESP enhancements are made, without sacrificing fuel flexibility. The NPVRR analysis results for Option 6 in Table ES-1 reflects a fuel costs increase of [redacted] (approximately 10% to 12% above current prices) based on projections developed by IPL's fuel procurement group. This price premium accounts for transportation and market price differentials to deliver the low-Hg content fuel to the Petersburg Station. Similarly, if only one baghouse is installed, as in Option 5, fuel flexibility will also be impacted though to a lesser extent. Since both of

commonly uses the term *dry sorbent injection* (DSI) to refer to this technology.

these options adversely affect fuel flexibility and have significantly larger evaluated costs, S&L does not recommend these control options.

Options 3 and 4 represent compliance beyond the minimum applicable standards based on the historical Hg content in the fuel. Should quarterly fuel samples indicate a trend toward increasing Hg content. Option 4, adding a third baghouse, could be implemented in the future. Options 1 or 2 could be implemented without interfering with the space needed to add a third baghouse. Although Option 3 based on providing a baghouse on Petersburg Units 3 and 4 provides additional margin for compliance with a larger range of fuels, the costs are significantly higher than if Options 1 and 2 were selected, where either Unit 3 or Unit 4 were provided with baghouses in combination with Unit 2. This higher cost is due to the need to rebuild the ESP on Unit 2, which is a cost similar to that of a new baghouse. Several studies document the deteriorating condition of the Unit 2 ESP. To reliably meet the MATS emission limits, the Unit 2 ESP would require a complete rebuild. Since both Options 3 and 4 represent significantly higher NPV costs, they are not recommended.

Options 1 and 2 have nearly equal NPVRR values; however, Option 1 (Units 2 and 3 baghouses) has the following additional advantages:

- The Unit 4 baghouse retrofit is more costly than would be the Unit 3 baghouse.
- Unit 4 does not currently have another major planned outage before the required 2016 compliance date.
- The Unit 3 baghouse has an SCR and thus may be dispatched more heavily in the future.
- Future technology retrofits are more likely to be developed that will enhance Hg removal for the more common forced oxidized Unit 4 wet FGD as opposed to the inhibited oxidization FGD technology used on Unit 3.

Based on these advantages and considering that Option 1 has the lowest evaluated NPVRR for the technically feasible options, S&L recommends that IPL implement the following control plan for Petersburg:

- Install a new baghouse for both Unit 2 and Unit 3.
- Add ACI and SI systems on Units 1-4.
- Provide wet FGD reliability enhancements on Units 1 and 2 for HCl emission compliance reliability.
- Provide ESP transformer rectifier (TR) set enhancements for ESP reliability for FPM compliance and to minimize ash loading to the wet FGD.

For Harding Street Unit 7, the control plan to achieve MATS compliance is less complex and projected to be achievable at a lower cost. The unit already burns two of the lowest-Hg content fuels available to the IPL system. Additionally, the proximity of these mines to the station lowers fuel costs. The testing showed that and the existing SBS system combined with a new ACI would supplement Hg collection when higher-Hg coal is received. Therefore, the evaluation concluded that the ESP operating as a system with the wet FGD is capable of reliably meeting the MATS Hg emissions limits. The combined ESP and wet FGD system, however, is incapable of reliably meeting the MATS FPM emission limits, and must be upgraded by expanding the collecting surface area and TR sets. However, the projected costs of this upgrade are less than the costs of installing a new baghouse. Since the wet FGD is required to provide supplemental FPM emission control and is the primary technology for HCl control, reliability and winterization upgrades are also recommended for the Harding Street wet FGD system as part of the MATS control plan.

The recommended MATS control plan is estimated to require a system-wide capital investment of $520 million, plus the utility cost for permitting, project management, AFUDC, Bonds, taxes, asset retirement, and other typical project owner costs. This amount also excludes price escalation that could result from a shift in market conditions from a buyer's market to a seller's market. This strategy represents a significant capital and operating cost savings over providing a baghouse on all five units. The capital costs, projected annual costs for reagents used by the ACI and SI systems, station annual O&M cost increases, and additional ash disposal costs required for MATS compliance are summarized for each unit in Table ES-2.

Table ES-2. IPL Big Five Unit MATS Compliance Costs

Unit Configuration	Capital Investment ($2012 Millions)	Annual Reagent Costs (SI/ACI)	Annual O&M Costs	Annual Ash Disposal Costs
Petersburg Station Unit 1	43	3.3	1.7	no impact
Petersburg Station Unit 2	186	3.2	2.4	no impact
Petersburg Station Unit 3	174	4.1	2.3	no impact
Petersburg Station Unit 4	37	10.9	1.8	2.8
Harding Street Unit 7	80	1.7*	1.9	no impact
Total System Compliance Costs	**520**	**23.2**	**10.1**	**2.8**

*Does not include existing SBS reagent costs

The components included in the capital costs estimates are summarized in Table ES-3.

Table ES-3. Environmental Control Plan Capital Cost Breakdown ($Million)

Cost Description	Pete Unit 1 -w- Existing ESP	Pete Unit 2 -w- New Baghouse	Pete Unit 3 -w- ESP & Polishing Baghouse	Pete Unit 4 -w- Existing ESP	HSS Unit 7 -w- Existing ESP
Capital (Equipment, Material & Labor)					
New Assets					
BH	NA	28,614,000	29,779,000	NA	NA
ESP Upgrades	950,000	NA	NA	1,750,000	24,500,000
Ductwork	NA	13,649,000	18,280,000	NA	5,300,000
Steel (Excluding Ductwork)	2,000,000	13,801,000	10,730,000	2,000,000	2,600,000
Fans	-	4,891,000	5,029,000	-	-
SI	3,070,000	3,315,000	3,360,000	3,890,000	400,000
ACI	1,230,000	1,182,000	1,357,000	1,620,000	1,200,000
CEMS (1.5 M per Stack system incl. Hg, HCL, FPM)	4,900,000	4,900,000	2,450,000	2,450,000	4,700,000
Electrical Equipment	600,000	5,249,000	6,869,000	600,000	600,000
BOP (Electrical, Air, Demo, Etc.)	4,823,000	28,970,000	21,030,000	3,660,000	4,000,000
BOP (Demo)	400,000	3,590,000	2,199,000	450,000	1,200,000
WFGD Upgrades	2,700,000	2,700,000	NA	NA	500,000
Relocation of Unit 3 BH to Flood Plain	-	-	NA	NA	NA
Other Direct and Const Indirect	4,842,000	29,738,000	27,639,000	3,846,000	10,539,000
Indirect Cost	3,876,100	15,466,000	14,159,000	3,613,100	6,109,000
Total Escalation	1,704,000	7,405,000	8,322,000	1,384,000	3,573,000
Total Contingency	6,064,000	20,661,000	19,436,000	4,899,000	12,330,000
Subtotal New Assets	37,159,100	184,131,000	170,639,000	30,162,100	77,551,000
Enhancements of Existing Assets					
ESP Enhancements	3,600,000		1,695,000	5,400,000	
Reduce Air Inleakage from Ducts	1,575,000	2,048,000	1,337,000	1,400,000	2,800,000
Reduce Air Inleakage from Fans	438,000	-	-	438,000	0
Subtotal Enhancements of Existing Assets	5,613,000	2,048,000	3,032,000	7,238,000	2,800,000
Total Project Costs	43,000,000	186,000,000	174,000,000	37,000,000	80,000,000

Although included in the NPVRR analysis for determining the appropriate compliance options, certain recurring periodic costs are not shown in Table ES-3 for those associated with continued use of the aging Petersburg Units 1, 3, and 4 ESPs, future replacements of baghouse filter bags, or wet FGD demister packing replacements. These costs are discussed in Section 8 of this report.

This study does not recommend that action be taken on the gypsum or wet FGD discharge liquids at this time. With ACI injection, Hg concentrations in both the gypsum and the wet FGD liquid waste stream will be less than current values. IPL may need to consider Hg content in the liquid waste stream as future regulations governing FGD discharges are promulgated.

1. INTRODUCTION

1.1 STUDY PURPOSE

On February 16, 2012, the U.S. Environmental Protection Agency (EPA) published in the *Federal Register* a final rule regulating hazardous air pollutant (HAP) emissions from coal- and oil-fired electric utility steam generating units (EGUs). The final rule became effective on April 16, 2012, with compliance required by April 16, 2015, with potential for a one-year extension granted by the State permitting agency. The rule, referred to as the Mercury and Air Toxics Standards Rule ("MATS Rule" or "Utility MACT Rule") requires coal- and oil-fired EGUs to meet HAP emission standards reflecting the application of the maximum achievable control technology (MACT). The rule includes emission limits for mercury (Hg), non-Hg metals, and acid gases, and could have a significant impact on IPL's coal-fired power plants.

Indianapolis Power & Light Company (IPL) contracted Sargent & Lundy, L.L.C. (S&L) to review HAP emission standards in the final MATS Rule, determine the impacts of the requirements on IPL's coal-fired units, and recommend an environmental control plan to bring those coal-fired units into compliance within the timeline required by the Rule.

Based on an evaluation of EPA's proposed MATS Rule published in May 2011, it was determined that IPL would work to derive an environmental control plan around its coal-fired Big Five Units, which comprise Petersburg Units 1-4 and Harding Street Unit 7. The evaluation of IPL's smaller coal-fired units includes considerations of possible repowering and retirement is beyond the scope of this study. Based on these earlier determinations, this study evaluates environmental control technology options and recommends an environmental control plan for the Big Five Units. The objectives of the recommended environmental control plan are to achieve: (1) emissions compliance, (2) generation reliability, and (3) a cost-effective plan.

1.2 STUDY APPROACH

The following tasks were performed to evaluate environmental compliance with the MATS Rule requirements and to develop the environmental control plan:

- Review the MATS Rule and identify the applicable emission limits and compliance requirements as they apply to each unit included in this study.
- Review IPL's coal procurement strategy and evaluate cost and other impacts of switching fuels.
- Perform diagnostic testing to determine feasibility of environmental controls at the Big Five Units.
- Review stack test results for the selected units and compare stack test data to the MATS Rule emissions limits to identify emission reductions needed to comply with the final Rule.
- Identify air pollution control technologies capable of reducing HAP emissions below the applicable MATS Rule emission limits. The feasible options to provide reliable emission compliance under two conditions are: (1) when each unit is at full load and firing the maximum Hg coal content, and (2) when averaging units' emissions, and using average Hg coal and one unit is in outage.
- Use test data to predict Hg, HCl, and FPM emissions for the Big Five Units.
- Evaluate the capital costs and recurring periodic costs of the selected control technologies.
- Consider fuel cost differentials for switching to lower-Hg coals.
- Perform a net present value revenue requirements (NPVRR) evaluation of compliance options.
- Recommend an environmental control plan.
- Develop a Level 1 implementation schedule to bring the selected units into compliance in accordance with the Rule's compliance timeline.

2. FINAL MATS RULE

On February 16, 2012, EPA published in the *Federal Register* the final rule regulating HAP emissions from coal- and oil-fired EGUs. The rule, referred to as the MATS Rule or Utility MACT Rule, requires coal- and oil-fired EGUs to meet HAP emission standards reflecting the application of the maximum achievable control technology (MACT). The rule became effective on April 16, 2012, with compliance required by April 16, 2015, with potential for a one-year extension granted by the State permitting agency. A summary of the final rule as it applies to IPL's coal-fired Petersburg Units 1-4 and Harding Street Unit 7, is provided below.

2.1 MATS RULE APPLICABILITY

The MATS Rule applies to new and existing coal- and oil-fired electric generating units (EGUs). An EGU is defined as a fossil fuel-fired combustion unit of more than 25 MW that serves a generator that produces electricity for sale. Coal-fired EGUs are defined in the rule as follows:

> Coal-fired EGUs include units that burn coal (either as a primary fuel or as a supplementary fuel) where the coal accounts for more than 10% of the average annual heat input during any 3 consecutive calendar years or for more than 15% of the annual heat input during any one calendar year.

Petersburg Units 1-4 and Harding Street Unit 7 all fire coal as their primary fuel and generate more than 25 MW of electricity for sale; thus, all five units are classified as coal-fired EGUs and are subject to the applicable MATS Rule requirements.

2.2 SOURCE SUBCATEGORIES

EPA subcategorized the coal-fired EGU source category into the subcategories listed in Table 2-1.

Table 2-1. EGU Source Subcategories

Subcategory	Description
Unit designed for coal >8,300 Btu/lb	Coal-fired EGU that is not in the "unit designed for low rank virgin coal" subcategory.
Unit designed for low rank virgin coal	Coal-fired EGU designed to burn and is burning nonagglomerating virgin coal having a calorific value (moist, mineral matter-free basis) of less than 8,300 Btu/lb that is constructed and operates at or near the mine that produces such coal.

The final rule does not differentiate between bituminous- and sub-bituminous-fired units. In general, all bituminous- and sub-bituminous-fired units fall into the "designed for coal >8,300 Btu/lb" subcategory, while lignite-fired units fall into the "designed for low rank virgin coal" subcategory. IPL's Petersburg Units 1-4 and Harding Street Unit 7 fall into the "designed for coal >8,300 Btu/lb" subcategory.

2.3 UTILITY MACT EMISSIONS LIMITS AND COMPLIANCE REQUIREMENTS

The final rule includes HAP emission limits and work practice standards for new and existing EGUs in each subcategory. A **new** unit is defined as a coal- or oil-fired EGU for which construction or reconstruction began after May 3, 2011. **Existing** units include coal-and oil-fired EGUs that are already operating, as well as those for which construction or reconstruction began prior to May 3, 2011. All of IPL's Big Five Units are coal-fired and were in operation prior to May 3, 2011, and are classified as existing coal-fired units.

The MATS Rule includes emission limits for mercury (Hg), non-Hg HAP metals, and acid gas HAP emissions. For coal-fired EGUs, the rule regulates HCl as a surrogate for acid gas emissions, with an alternate SO_2 emission limit for units with FGD systems installed and operational. Filterable PM (FPM) emissions are regulated as a surrogate for non-Hg HAP metal emissions, with total non-Hg metals and individual non-Hg metals as alternative equivalent standards. Work practice standards were included for organic HAP control for all EGU subcategories.

Emission standards for the existing "designed for coal >8,300 Btu/lb" subcategory (i.e., the subcategory that applies to the Petersburg and Harding Street coal-fired units) are summarized in Table 2-2.

Table 2-2. MATS Emission Standards for the Existing "Designed for Coal >8,300 Btu/lb" EGU Subcategory

Existing Coal-Fired EGUs[(1)]	Non-Hg HAPS Metals	Acid Gases	Mercury (Hg)
Existing coal-fired unit designed for > 8,300 Btu/lb (bituminous- and sub-bituminous-fired boilers)	FPM 0.030 lb/MMBtu or Total non-Hg HAP Metals[(2)] 0.000050 lb/MMBtu or Individual HAP Metals[(2)]	HCl 0.0020 lb/MMBtu [~2 ppmvd @ 3% O_2] or SO_2[(3)] 0.20 lb/MMBtu	Hg 1.2 lbs/TBtu (0.013 lb/GWh) or Hg 1.0 lb/TBtu *when using a 90-day average of multiple EGUs*

(1) In addition to the heat input-based emission standards listed in the table, the rule includes equivalent (lb/MWh) emission limits for each regulated HAP.

(2) The Total non-Hg HAP Metals emission limits equals the sum of: Antimony (Sb), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Lead (Pb), Manganese (Mn), Nickel (Ni), and Selenium (Se). As an alternative to the total non-Hg metals limit, owners/operators can choose to demonstrate compliance with the individual non-Hg metal limits included in Table 2 to Subpart UUUUU of Part 63.

(3) You may not use the alternate SO_2 limit if your coal-fired EGU does not at all times operate a FGD system and have SO_2 CEMS installed.

Emission limits summarized in Table 2-2 are based on a 30-boiler-operating-day average, and apply at all times excluding periods of startup and shutdown. For periods of startup and shutdown, the final rule includes work practice standards in lieu of numeric emission limits. The final rule also includes work practice standards for the control of organic HAP emissions for all EGU subcategories.

2.4 NON-MERCURY HAP METALS

The MATS Rule includes non-Hg HAP metal emission limits for existing coal-fired EGUs. For the existing "designed for coal >8,300 Btu/lb" subcategory, the rule includes an FPM emission limit of 0.030 lb/MMBtu (30-day average) as a surrogate for the non-Hg HAP metals. As an alternative to meeting the FPM emission limit, existing units can choose to demonstrate compliance with a total non-Hg metals emission limit of 0.00005 lb/MMBtu (50 lbs/TBtu) or individual non-Hg metal emission limits.

2.4.1 Compliance Requirements

Table 2-3 provides a general overview of options for complying with the non-Hg HAP metal emissions standards. The MATS Rule includes an emissions averaging option for facilities with more than one EGU. The emissions averaging option is described further in subsection 2.7 of this report. In addition, units that continuously achieve emissions that are less than 50% of the applicable emissions standard can qualify as a low emitting EGU (LEE). The LEE option is described further in subsection 2.8.

Table 2-3. Compliance Options for Non-Hg HAP Metal Emissions

HAP	Emission Limit	Compliance Monitoring Requirements
FPM	0.030 lb/MMBtu (30-boiler-operating-day average)	PM CEMS or PM CPMS or Quarterly Stack Tests
Total Non-Hg Metals	0.000050 lb/MMBtu	
Individual Non-Hg Metals	Sb = 0.8 lb/TBtu As = 1.1 lbs/TBtu Be = 0.20 lb/TBtu Cd = 0.30 lb/TBtu Cr = 2.8 lbs/TBtu Co = 0.80 lb/TBtu Pb = 1.2 lbs/TBtu Mn = 4.0 lbs/TBtu Ni = 3.5 lbs/TBtu Se = 5.0 lbs/TBtu	
Emissions Averaging	Average emissions from all participating EGUs are below the applicable emission limits listed above (FPM, total non-Hg metals, or individual non-Hg metals)	Emissions averaging is based on a heat input (or gross electrical output) weighted average
Low-Emitting EGU (LEE)	Measured emissions must be at least 50% less than the applicable emission limit	After a 3-year period during which every emissions test shows emissions no greater than 50% of the applicable emission limit, the emissions testing frequency for that specific pollutant can be reduced to once every 36 months

2.4.2 Compliance Monitoring

The MATS Rule requires owners/operators of affected EGUs to demonstrate initial and continuous compliance with each applicable emission limit. Where options for emission limits apply (such as FPM, total non-Hg metals, or individual non-Hg metals), the rule requires that the owner/operator only perform testing to demonstrate compliance with the selected emission limit. Initial compliance may be demonstrated with stack testing or using a certified continuous emission monitoring system (CEMS). Initial performance tests generally consist of three test runs at specified process operating conditions using an approved test method (e.g., Test Method 5 for FPM and Test Method 29 for total or individual non-Hg metals). To demonstrate initial compliance with the FPM emission limit using a PM CEMS, the initial performance test consists of 30 boiler operating days of data collection with the certified monitoring system by the initial compliance demonstration date specified in the rule.

The final rule provides two basic emissions monitoring approaches to demonstrate continuous compliance with the applicable emission limits: (1) CEMS; or (2) periodic quarterly stack testing. The final rule also allows owners/operators to demonstrate continuous compliance with the non-Hg HAP metals limit (either FPM, total non-Hg metals, or individual non-Hg HAP metals) using a PM continuous parameter monitoring system (CPMS). PM CPMS continuously measure one or more operating parameter that can be correlated to the initial stack test results. The operating principle of the PM CPMS must be based on in-stack or extractive light scatter, light scintillation, beta attenuation, or mass accumulation detection of the exhaust gas or representative sample. Reportable measurement output from the PM CPMS may be expressed as milliamps, stack concentration, or other raw data signal. The PM CPMS must have a cycle time (i.e., period required to complete sampling, measurement, and reporting for each measurement) no longer than 60 minutes, and must be capable, at a minimum, of detecting and responding to particulate matter concentrations of 0.5 mg/acm.

Units choosing to demonstrate continuous compliance using a PM CPMS system must establish a site-specific "operating limit" during the initial performance test (or any subsequent performance test) that demonstrates compliance with the FPM, individual non-Hg metals, or total non-Hg metals limit. This is done by recording all hourly average output values from the CPMS system (e.g., milliamps, stack concentration, or other raw data signal) for periods corresponding to the stack test runs (e.g., nine 1-hour average PM CPMS output values for three 3-hour test runs). The unit-specific operating limit corresponds to the highest 1-hour average PM CPMS output value recorded during the performance test. Continuous compliance with the operating limit is demonstrated by operating and maintaining the control equipment such that the 30-boiler-operating-day-average PM CPMS output does not exceed the operating limit determined above.

2.5 ACID GASES

The MATS Rule includes acid gas emission standards for existing coal-fired EGUs. For the existing "designed for coal >8,300 Btu/lb" subcategory, the rule includes an HCl emission limit of 0.0020 lb/MMBtu (30-boiler-operating-day average) as a surrogate for acid gas emissions. As an alternative, for existing units equipped with an FGD control system, owners/operators can meet an SO_2 emission limit of 0.20 lb/MMBtu (30-boiler-operating day-average). Existing coal-fired units equipped with an FGD control system that operates at all times can choose to demonstrate compliance with the MATS Rule acid gas requirement by demonstrating compliance with either the HCl or SO_2 emission limits.

2.5.1 Compliance Requirements

Table 2-4 provides a general overview of options for complying with the acid gases emissions standards. The rule includes an emissions averaging option for facilities with more than one EGU in the same subcategory. The emissions averaging option is described further in subsection 2.7 of this report. In addition, units that continuously achieve emissions that are less than 50% of the applicable HCl emission standard can qualify as a LEE. The LEE option is described further in subsection 2.8.

Table 2-4. Compliance Options for Acid Gas Emissions

HAP or Surrogate	Emission Limit	Compliance Monitoring Requirements
HCl	0.0020 lb/MMBtu (30-boiler-operating-day average)	HCl CEMS or Quarterly Stack Testing
SO_2	0.20 lb/MMBtu (30-boiler-operating-day average)	SO_2 CEMS
Emissions Averaging	Average emissions from all participating EGUs are below the applicable emission limits listed above (HCl or SO_2) (30-boiler operating day average)	Emissions averaging is based on a heat input (or gross electrical output) weighted average
Low-Emitting EGU (LEE)	Measured HCl emissions must be at least 50% less than the applicable emission limit	After a 3-year period during which every emissions test shows emissions no greater than 50% of the applicable emission limit, the emissions testing frequency for that specific pollutant can be reduced to once every 36 months

2.5.2 Compliance Monitoring

The MATS Rule requires owners/operators of affected EGUs to demonstrate initial and continuous compliance with each applicable emission limit. Where options for emission limits apply (such as HCl or SO_2) the rule requires that the owner/operator only perform testing to demonstrate compliance with the selected emission limit. Initial compliance may be demonstrated with stack testing (for HCl) or using a certified HCl or SO_2 CEMS, as applicable. Initial performance tests generally consist of three test runs at specified process operating conditions using an approved test method (e.g., Test Methods 26 or 26A for HCl). The initial performance test for units demonstrating compliance with a CEMS consists of 30-boiler operating days of data collection with the certified monitoring system prior to the initial compliance demonstration date specified in the rule.

The final rule provides two basic emissions monitoring approaches to demonstrate continuous compliance with the applicable acid gas emission limits: (1) use of an HCl or SO_2 CEMS; or (2) quarterly stack testing for HCl. It should be noted that the SO_2 compliance option is only available to coal-fired units equipped with an FGD control system that operates at all times.

2.6 MERCURY

The MATS Rule includes mercury emission limits for existing coal-fired EGUs. For the existing "designed for coal >8,300 Btu/lb" subcategory, the rule includes a mercury emission limit of 1.2 lbs/TBtu (30-boiler-operating-day average).

2.6.1 Compliance Requirements

Table 2-5 provides a general overview of options for complying with the mercury emissions limit. The rule includes an emissions averaging option for facilities with more than one EGU. The emissions averaging option is described further in subsection 2.7 of this report. In addition, units that continuously achieve emissions that are less than 10% of the standard (or less than 29 lbs Hg/year) can qualify as a LEE for mercury. The LEE option is described further in subsection 2.8.

Table 2-5. Compliance Options for Hg Emissions

HAP	Emission Limit	Compliance Monitoring Requirements
Hg	1.2 lbs/TBtu (30-boiler-operating-day average)	Hg CEMS or sorbent trap monitoring system.
Emissions Averaging	1.0 lb/TBtu (90-boiler-operating-day average)	
Low-Emitting EGU	Measured emissions must be less than 10% of the applicable limit shown above or less than 29 lbs/yr	Conduct an initial Method 30B test over 30 days and follow the calculation procedures in the final rule to document a potential-to-emit less than 10% of the applicable emission limit or less than 29 lbs/year. Units that quality as a LEE for Hg must conduct an annual 30-day Method 30B performance test each year to reestablish that the unit continues to qualify as a LEE for Hg.

2.6.2 Compliance Monitoring

Compliance with the MATS Hg emission limit must be demonstrated using an Hg CEMS or sorbent trap continuous monitoring system, with the exception of coal-fired EGUs that qualify as a LEE for Hg emissions. Both types of monitoring technologies require certification with Relative Accuracy Test Audit (RATA) testing, in addition to weekly and quarter quality assurance testing. Unlike the non-Hg metals and HCl, the MATS Rule does not include a stack test option for Hg compliance.

2.7 AVERAGING OPTION

The MATS Rule allows owners/operators of existing affected sources to demonstrate compliance with the MATS standards by emissions averaging. Emissions-averaging allows owners/operators of a facility with more than one existing EGU within the same subcategory to demonstrate that the source (i.e., the facility) complies with the applicable MATS emission standards by averaging emissions from the individual units. The emissions averaging option would be available to Petersburg Units 1-4, but would not be available to Harding Street Unit 7. Emissions averaging may be used as an alternative to meeting the requirements for Hg, FPM, HCl, SO_2, and/or non-Hg HAP metals on an individual basis. New units, and units in different subcategories, are excluded from the emissions averaging provisions.

Except for Hg emissions from EGUs in the “designed for coal >8,300 Btu/lb” subcategory, owners/operators can demonstrate compliance with the MATS emission standards if averaged emissions from individual units located at the same facility (and in the same subcategory) are equal to or less than the applicable emissions limit. For Hg emissions from existing EGUs in the “designed for coal >8,300 Btu/lb” subcategory only, owners/operators must use an alternative emission limit of 1.0 lb/TBtu based on a 90-boiler-operating-day rolling average (rather than the 1.2 lbs/TBtu 30-day average that applies to individual units in the subcategory).

The final rule requires each facility that intends to utilize emissions averaging to develop an emissions averaging plan. The emissions averaging plan must include the following information: (1) identification of all existing units in the averaging group; (2) description of control technologies installed on each unit; (3) the process weighting parameter that will be monitored (e.g., heat input, gross electrical output, or steam generated); (4) the means of measurement of the HAP being averaged (e.g., CEMS, sorbent trap monitoring, manual performance tests); and (5) a demonstration that emissions averaging can produce compliance with each of the applicable emission limits.

2.8 LOW-EMITTING EGU STATUS

Existing units can qualify for LEE status for one or more HAP emission standard (not including the SO_2 standard). In general, units will qualify for LEE status if compliance tests demonstrate that emissions, with the exception of mercury, are less than 50% of the applicable emission limit. Units can qualify for LEE status for Hg if emissions are less than 10% of the applicable emission limit or potential annual emissions are less than 29 pounds per year. Units that qualify for LEE status are subject to reduced monitoring requirements.

Units can qualify for LEE status for Hg emissions by conducting an initial Method 30B (sorbent trap methodology) test over 30 days and follow the calculation procedures in the final rule to document actual Hg emissions of less than 10% of the applicable Hg emission limit, or a potential to emit less than 29 lbs Hg/year (and the unit also meets its applicable mercury emission limit). Units that qualify as a LEE for Hg must conduct subsequent performance tests on an annual basis (i.e., 30-day Method 30B performance test) to demonstrate that the unit continues to qualify. If the results of the LEE test show that the unit exceeds 10% of the emissions limit or exceeds the potential-to-emit of 29 lbs/yr, the unit will lose its LEE status, and will be required to demonstrate continuous compliance with the applicable mercury emission limit using a Hg CEMS or sorbent trap monitoring system. Units can regain LEE status if every required performance test for a three-year period shows that Hg emissions from the unit did not exceed the applicable LEE limits.

Units can qualify for LEE status for all other pollutants (e.g., FPM, total non-Hg metals, and HCl) by conducting the initial compliance tests, and then all other required tests over a three-year period, and all such test results must be less then 50% of the applicable emission limit. A unit that qualifies as a LEE on that basis can reduce its emissions testing frequency for that specific non-mercury pollutant to once every 36 months. If any subsequent emissions test for that pollutant exhibits emissions greater than 50% of the applicable emission limit, the unit must revert to the original emissions testing frequency until it can reestablish a three-year period of emissions below the LEE standard.

Unfortunately, the MATS Rule does not allow units with bypass stacks to employ the LEE alternative. All of the Big Five Units have bypass stacks.

2.9 UTILITY MACT WORK PRACTICE STANDARDS

In general, emission limits included in the MATS Rule are based on a 30-boiler-operating-day average and apply at all times excluding periods of startup and shutdown. For periods of startup and shutdown, the final rule includes work practice standards in lieu of numeric emission limits. The final rule also includes work practice standards for the control of organic HAP emissions for all EGU subcategories.

2.9.1 Work Practice Standards – Control of Organic HAP Emissions

For the control of organic HAP emissions, owners/operators must conduct a tune-up of the EGU burner and combustion control systems at least once every 36 calendar months, or once every 48 calendar months if neural network combustion optimization software is employed during all normal operation. The work practice standard involves maintaining and inspecting the burners and associated combustion controls, tuning the specific burner type to optimize combustion, and obtaining and recording carbon monoxide (CO) and NO_X values before and after burner adjustments. Tune-up work practice standards include (as applicable):

- Inspect the burner and combustion controls, and clean or replace any components of the burner or combustion controls as necessary upon initiation of the work practice program and at least once every required inspection period.
- Inspect the flame pattern and make any adjustments to the burner or combustion controls necessary to optimize the flame pattern, consistent with the manufacturer's specifications or in accordance with best combustion engineering practices for that burner type.
- Observe the damper operations as a function of mill and/or cyclone loadings, cyclone and pulverizer coal feeder loadings, or other pulverizer and coal mill performance parameters, making adjustments and effecting repair to dampers, controls, mills, pulverizers, cyclones, and sensors.
- Evaluate windbox pressures and air proportions, making adjustments and effecting repair to dampers, actuators, controls, and sensors.
- Inspect the system controlling the air-to-fuel ratio and ensure that it is correctly calibrated and functioning properly. Any component out of calibration, in or near failure, or in a state that is likely to negate combustion optimization efforts prior to the next tune-up, should be corrected or repaired as necessary.
- Optimize combustion to minimize generation of CO and NO_X. This optimization should be consistent with the manufacturer's specifications, if available, or best combustion engineering practice for the applicable burner type:
  - — NO_X optimization includes burners, overfire air controls, concentric firing system improvements, neural network or combustion efficiency software, control systems calibrations, adjusting combustion zone temperature profiles, and add-on controls such as selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR).
  - — CO optimization includes burners, overfire air controls, concentric firing system enhancements or upgrades, neural network or combustion efficiency software, control systems calibrations, and adjusting combustion zone temperature profiles.

2.9.2 Work Practice Standards – Startup/Shutdown

The final rule includes work practice standards that apply during periods of unit startup and shutdown. The terms "startup" and "shutdown" are defined in the final rule as:

> **Startup** means either the first-ever firing of fuel in a boiler for the purpose of producing electricity, or the firing of fuel in a boiler after a shutdown event for any purpose. Startup ends when any of the steam from the boiler is used to generate electricity for sale over the grid or for any other purpose (including on-site use).
>
> **Shutdown** means the cessation of operation of a boiler for any purpose. Shutdown begins either when none of the steam from the boiler is used to generate electricity for sale over the grid or for any other purpose (including on-site use) or at the point of no fuel being fired in the boiler, whichever is earlier. Shutdown ends when there is both no electricity being generated and no fuel being fired in the boiler.

Work practice standards that apply during periods of startup and shutdown include:

- Sources must use "clean fuels" (i.e., natural gas or distillate oil) or a combination of clean fuels, for ignition during startup;
- All CEM systems must be operated during periods of startup and shutdown;
- Once the unit converts to firing coal, residual oil, or solid oil-derived fuel, operators must:
  - — Engage all of the applicable control technologies, except dry scrubbers and SCRs; and
  - — Start the dry scrubber and SCR control systems, if present, appropriately to comply with relevant standards applicable during normal operation.

2.10 EMISSIONS CONTROL TECHNOLOGIES AND EMISSIONS REQUIREMENTS

The final rule does not specifically list control technologies that are required to achieve the MATS emission standards. Coal- and oil-fired EGUs are simply required to meet the applicable HAP emission limits using whatever control technology, or combination of technologies, they deem appropriate for their specific situation. In general, control technology requirements will be a function of the coal being fired and the performance of existing air pollution control systems.

Sections 3, 4, and 5 compare the MATS Rule emission limits applicable to the IPL coal-fired units to stack test data available from the generating units, and provide a detailed evaluation of the air pollution control technologies that may be available to meet the MATS standards for existing coal-fired boilers.

2.11 COMPLIANCE TIMELINE

Compliance with the MATS emission standards is required within three years of the effective date of the rule (i.e., April 16, 2015). However, if an existing source is unable to comply within three years, the permitting authority (generally the State) has the ability to grant up to a one-year extension, if additional time is necessary for the installation of controls. Permitting authorities have the discretion to issue an extension to address a range of situations in which installation schedules may take more than three years, including: staggering installations for reliability reasons or other site-specific challenges that might arise related to source-specific construction, permitting, labor, procurement, or resource challenges. In the preamble to the final rule EPA stated that the "fourth year should be broadly available to enable a facility owner to install controls within 4 years if the three-year time frame is inadequate for completing installation." (77 Fed, Reg. page 9410, col. 1)

EPA also noted that the Clean Air Act provides additional flexibilities to bring sources into compliance while maintaining electric reliability. On December 16, 2011, EPA's Office of Enforcement and Compliance Assurance issued a memorandum articulating the Agency's intended approach with respect to sources that operate in noncompliance with the MATS Rule to address specific and documented reliability concerns. The memorandum provides a mechanism for "reliability-critical" units to achieve compliance within an additional year. The result is that qualifying reliability-critical units may come into compliance within up to 5 years of the effective date of the rule (i.e., April 2017).

3. COMPLIANCE WITH ACID GASES REQUIREMENTS

3.1 BACKGROUND

Acid gas compliance requirements are discussed in Section 2 (Final MATS Rule) of this report. From the choice of two acid gas compliance options (i.e., HCl or SO_2), IPL has decided to evaluate compliance with the HCl emission limit, which is reported on a 30-day averaging period. The Rule also allows IPL to demonstrate compliance on a per unit basis or on a station average basis.

IPL performed stack testing on Petersburg Units 2 and 3 and on Harding Street Unit 7 in 2011. The results showed that all three of the units were in compliance with the MATS HCl limit of 0.002 lb/MBtu. Test results support the expectation that the wet FGD control systems are effectively removing HCl from the flue gas, with the attendant low emission values. Typically, a wet FGD system with a 95% SO_2 removal efficiency will have an even higher HCl removal efficiency.

Stack test results, in conjunction with the control technology evaluation, indicate that the Petersburg and Harding Street units included in this report are expected to achieve HCl emissions to below the MATS HCl limit of 0.002 lb/MMBtu on a 30-day average with no additional controls. The preferred method of demonstrating compliance is via an HCl continuous emission monitoring system (CEM or CEM system). The preferred method of reporting compliance for Petersburg is via station-averaging because this will mitigate differences in the coal chloride content from mine to mine. Harding Street Unit 7 will not have the option to average emissions, but will comply with the MATS limit without averaging.

The following topics as related to acid gas compliance are discussed below:

- Coal basis
- Results of 2011 testing
- Results of diagnostic testing
- Evaluation of control equipment
- FPM equipment options
- Conclusions

3.2 COAL BASIS

Several coals are fired at both the Petersburg and Harding Street stations, all with differing chloride concentrations and heating values. All of these coals are from southwestern Indiana. The anticipated range of chlorine concentrations in the coals fired at Petersburg and Harding Street stations are summarized in the Table 3-1.

Table 3-1. Chlorine Content of the Current IPL Coals

	Moisture (% AR Basis)	HHV (BTU/lb, AR Basis)	Cl (ug/g Dry Basis)	Cl (ug/g AR Basis)	Cl (lb/MMBTU)
Mine 1	12.53	11,599	58	50.7	0.00437
Mine 2	14.18	11,476	107	91.6	0.00798
Mine 3	13.49	11,220	116	99.9	0.00891
Mine 4	14.57	11,512	130	111.3	0.00967
Mine 5	13.23	11,433	143	123.9	0.01084
Mine 6	13.74	11,169	168	144.6	0.01295
Mine 7	12.50	11,117	171	149.4	0.01344
Mine 8	13.60	11,115	174	150.3	0.01353
Mine 9	14.18	11,282	227	194.8	0.01727
Mine 10	14.48	11,161	440	375.8	0.03368
Mine 11	13.15	11,553	560	486.4	0.04210
Mine 12	12.00	11,800	700	616.0	0.05220
Mine 13	14.94	11,501	987	839.4	0.07298

Data on coals received at Petersburg since 2007 were also reviewed for chlorine content. The average during this time period ranged from approximately 100 parts per million (ppm) to 900 ppm (dry basis) and was similar to the range of chlorine concentrations shown in Table 3-1. S&L's evaluation considered the entire range of chlorine concentrations shown in the table in order to assess whether the existing FGD systems would provide compliance at the Big Five Units.

3.3 RESULTS OF 2011 TESTING

IPL performed stack tests at Petersburg Units 2 and 3 and Harding Street Unit 7 in 2011, and measured HCl emissions using EPA Method 26A. The test results showed that the existing HCl emissions from all three of these units are below the applicable MATS emission limit. Average results of the three test runs completed at each unit are as follows:

- Petersburg Unit 2 had HCl of 0.00057 lb/MMBtu and 742 ppm in coal, for a removal efficiency of 99.2%.
- Petersburg Unit 3 had HCl of 0.00022 lb/MMBtu and 92 ppm in coal, for a removal efficiency of 97.4%.
- Harding Street Unit 7 had HCl of 0.00074 lb/MMBtu and 662 ppm in coal, for a removal efficiency of 98.8%.

At all three of the units, HCl emissions were less than half of the MATS compliance limit, which would qualify these units for LEE status. Note that LEE status is not an option for these units since the configuration includes a bypass stack.

3.4 DIAGNOSTIC TESTING RESULTS

The results of the stack tests conducted in 2011 were as expected. No testing using Method 26A was conducted in 2012.

Removal efficiencies measured during the 2011 stack tests were used to predict the HCl emission when firing the high-chlorine coals. In general, results from the 2011 stack tests suggest that removal efficiencies in the range of 97% will be achieved when firing lower-chlorine coals (see, test result for Petersburg Unit 3), and that removal efficiencies of 99% or greater will be achieved when firing higher-chlorine coals (see, test results for Petersburg Unit 2 and Harding Street Unit 7).

Additionally, the FGD systems at the Big Five Units all are designed to achieve high SO_2 removal efficiencies. An FGD system's HCl removal efficiency typically will be slightly higher than its SO_2 removal efficiencies. HCl is very soluble and is easily collected in a wet FGD system. Typical removal efficiencies and liquid-to-gas ratios are shown in Table 3-2. The table shows that the SO_2 removal efficiencies are all in the high 90% range. Therefore, it is reasonable to conclude that HCl collection efficiencies of all of the units will be similar to the efficiencies of the three units tested in 2011.

Table 3-2. FGD Design Characteristics, Big Five Units

Station-Unit	Liquid/Gas	Typical SO_2 Removal	Absorber Design (Open, Tray, Other)
Petersburg 1	125 gal/1000 acfm	>98%	Open tower with liquid distribution rings and multiple spray levels
Petersburg 2	150 gal/1000 acfm	>97%	Open tower with liquid distribution rings and multiple spray levels
Petersburg 3	95 gal/1000 acfm	>94%	Spray tower with trays and multiple spray levels
Petersburg 4	120 gal/1000 acfm	>96%	Spray tower with trays and multiple spray levels
Harding Street 7	157 gal/1000 acfm	>98%	Two-pass tower with fountain sprays

To verify that future coals will comply with the MATS limit, the above chloride removal efficiencies were used to predict stack HCl values for each mine, based on the chlorine levels in the coal. The predicted emission rates are shown in Table 3-3. Because of the expected high HCl removal efficiencies, the predicted emission rates across the entire range of coals are below 0.001 lb/MMBtu, which is less than half of the MATS emission limit.

Table 3-3. Predicted HCl Emissions for Potential Coals

	HCl Emissions, FGD In (lb/MMBtu)	Removal Efficiency (%)	Predicted Outlet Emissions (lb/MMBtu)
Mine 1	0.00437	97.0	0.00013
Mine 2	0.00798	97.0	0.00024
Mine 3	0.00891	97.0	0.00027
Mine 4	0.00967	97.0	0.00029
Mine 5	0.01084	97.0	0.00033
Mine 6	0.01295	97.0	0.00039
Mine 7	0.01344	97.0	0.00040
Mine 8	0.01353	97.0	0.00041
Mine 9	0.01727	97.0	0.00052
Mine 10	0.03368	99.0	0.00034
Mine 11	0.04210	99.0	0.00042
Mine 12	0.05220	99.0	0.00052
Mine 13	0.07298	99.0	0.00073

Although, coal chlorine concentration can vary somewhat, over the course of a 30-day period, it is unlikely that these short-term variations in coal chlorine concentrations over a given 30-day period would cause the HCl emissions to double. Therefore, in S&L's judgment, the Big Five Units should meet the MATS HCl emission limits with the existing wet FGD systems due to the HCl removal capability of the wet FGD systems. However, one scenario where HCl emissions could exceed the MATS limit is when the FGD system is bypassed due to equipment malfunctions. During such a period, the HCl emissions would be significantly above the MATS emission limit. If the bypass period is short, the short-term excursion in HCl emissions will have a limited impact on the 30-boiler-operating-day average. For an extended period of bypass operation, the excursion could cause an exceedance of the HCl limit. The amount of time a unit's FGD system could be bypassed without exceeding the MATS limit was calculated for the Big Five Units. In addition to HCl removal from the FGD, the Hg reduction technology will include SI, which will remove a portion of the HCl from the flue gas. The additional HCl removal renders the predicted emission reductions in Table 3-3 even lower.

At Petersburg, station averaging can be used to increase the amount of time an FGD can be bypassed. Currently, Petersburg Units 3 and 4 do not bypass during normal operations. Units 1 and 2 do bypass on occasion. Table 3-4 shows the number of hours of each of the Petersburg unit's FGD could be bypassed over a 30-day averaging period without exceeding the MATS limit, as long as the other three FGD systems are kept in service. The basis of each was the highest coal HCl and 99% removal of HCl in the wet FGD systems.

Table 3-4. Petersburg Maximum Allowable FGD Downtime, Averaging HCl Limits

Station-Unit	FGD Downtime, Hours
Petersburg 1	92
Petersburg 2	50

Station averaging can be used at the Petersburg Station to increase the amount of time a wet FGD system can be bypassed without exceeding the MATS emission limit.

Harding Street Unit 7 would be limited to approximately 11 hours of wet FGD bypass during a 30-day averaging period at full load. The wet FGD control system must be able to limit bypasses to fewer than that number of hours to ensure MATS compliance. The basis of each was the highest coal HCl and 99% removal of HCl in the wet FGD systems.

3.5 EVALUATION OF CONTROL EQUIPMENT

The Big Five Units are predicted to be in compliance with MATS HCl limits when the wet FGD control systems are operating normally, and no additional HCl control equipment is needed. Upgrades are needed to keep the FGD systems in service and to minimize the duration of bypasses. IPL has a plan to improve the reliability on all of their FGD systems, which is encompassed by the MATS control plan.

The FGD system is vital to capturing FPM, HCl, and Hg. If, for some reason, the wet FGD system is not treating the flue gas, for example when the FGD absorber is bypassed, there is risk of non-compliance with the MATS emission limits.

Petersburg Units 3 and 4 currently do not bypass during normal operation, but do bypass during startup, when firing oil. This is done to prevent oil from entering and contaminating the recycle slurry. As these units currently have a three-hour SO_2 emission limit, the FGD absorber is always in service and no flue gas is bypassed. Therefore, no action is needed to mitigate the effects of an FGD system bypass at Petersburg Units 3 and 4.

Petersburg Units 1 and 2 each have the ability to bypass the FGD absorber upon equipment failure. Each unit has a chimney liner that is dedicated to the bypassed flow from the unit. In order to minimize the number and duration of FGD system bypass events for these units, potential FGD system upgrades were identified along with their associated capital costs. These are listed in Table 3-5.

Table 3-5. Petersburg Units 1 and 2 FGD System Costs

Activity	Unit 1 Cost	Unit 2 Cost	Impact
Install FGD recycle pump, discharge isolation valves, and other critical pumps	$2,700,000	$2,700,000	These valves will allow a single recycle pump to be maintained or quickly replaced while all other pumps are operating. This will reduce the frequency of bypasses because a pump can be repaired or replaced and brought back on line in a short period of time. This avoids a bypass because the station currently has to bypass and then install a bladder in the discharge pipe to isolate a pump. The same is true after they finished fixing a pump, the station bypasses to remove the bladder.
Maintain critical spare equipment (spare recycle pumps and other pumps)	Included in above	Included in above	The station currently operates all of these recycle pumps to meet liquid flow requirements. A spare pump would allow for quicker replacement should one pump fail. Purchase of these pumps will have a long lead time.
Increase demister packing replacement	$150,000/year	$150,000/year	To minimize the FPM in the stack, mist eliminator plugging should be minimized.

Harding Street Unit 7 has the ability to bypass flue gas before it reaches the FGD absorber. This bypass occurs when there is an FGD equipment failure and the bypass is to the original chimney. In order to minimize the number and duration of FGD system bypass events for this unit, potential FGD system upgrades were identified along with their associated capital costs. These are listed in Table 3-6.

Table 3-6. Harding Street Unit 7 FGD System Costs

Activity	Unit 7 Cost	Impact
Prevent critical FGD equipment from freezing.	$500,000	These upgrades will prevent reagent feed pumps and other pumps from freezing during winter.

3.6 CONCLUSIONS

The following conclusions are made based on an evaluation of available stack test data from the Petersburg and Harding Street stations and a review of the existing wet FGD control systems:

- Stack test data confirm the expectation that the existing wet FGD control systems effectively capture HCl emissions, and that existing HCl emissions from all Big Five Units are below the MATS HCl emission limit. All five units should be able to comply with the MATS HCl emission limit using the existing wet FGD control systems and with no additional HCl controls.
- The controls needed for Hg and FPM compliance will not have an impact on the ability of the FGD systems to comply with MATS HCl limits.
- IPL is upgrading the wet FGD systems at Petersburg Units 1 and 2 and at Harding Street Unit 7 to minimize the impact of FGD system operating malfunctions and to minimize the hours of FGD system bypass.

4. COMPLIANCE WITH FPM REQUIREMENTS

4.1 BACKGROUND

Non-Hg metal HAPS compliance requirements are discussed in Section 2 (Final MATS Rule) of this report. IPL had the choice of three compliance options for non-Hg HAP metals, and has decided to evaluate compliance with the FPM emission limit. The Rule allows IPL to show compliance on a per unit basis or on a station average basis. For Petersburg, IPL opted to evaluate compliance on a 30-day station average. Harding Street Unit 7 does not have the averaging option and, as such, was evaluated for compliance on a unit-only basis.

IPL performed PM stack testing at Petersburg Units 2 and 3 and Harding Street Unit 7 in 2011. The results from these tests show that all three of the units were in compliance with the MATS FPM limit. In an effort to understand the mechanism of FPM reduction and in order to maintain confidence in the results, IPL conducted additional diagnostic testing in 2012 and confirmed that Petersburg Unit 2 and Harding Street Unit 7 were in compliance. The results of this diagnostic testing suggest that the ESPs remove most of the FPM, but not enough to meet the FPM emission limit. In fact, the wet FGD system provides additional FPM removal, reducing FPM emissions at the stack below the MATS limit.

The stack test results taken together with the control technologies evaluated indicate that the existing ESPs and wet FGD systems at Petersburg are expected to achieve FPM emissions to below the MATS FPM limit of 0.030 lb/MMBtu on a 30-day average. The preferred method of demonstrating compliance is via a PM CEMS. The preferred method of reporting compliance for Petersburg is via station-averaging, as this would allow an ESP on one unit to operate marginally and the other units can then average out the emissions until the ESP can be repaired. Since two baghouses are included at Petersburg to meet MATS Hg limits (discussed in Section 5 of this report), the averaging is even more beneficial. Finally, the wet FGD systems do emit some FPM through the mist eliminators and IPL will need to maintain this equipment to minimize the potential impact on FPM emissions. Operation of the wet FGD system on each unit is essential to ensure compliance both with the HCl and FPM emission limits; therefore, FGD bypassing must be minimized.

The following topics as related to non-Hg metal compliance are discussed below:

- Coal basis
- Results of 2011 testing
- Results of diagnostic testing
- Evaluation of control equipment
- FPM equipment options
- Conclusions

4.2 COAL BASIS

Several coals are fired at both stations, all with differing ash and heating values. The coals are sourced from southwestern Indiana, as discussed earlier in this report. The fly ash generated by the coal is of most concern when evaluating PM collection and FPM compliance.

Available coal data were evaluated to identify the highest fly ash loading that could be expected from the coals. From the data, the maximum ash values for Petersburg and Harding Street are 10.5% and 11.5% on a dry basis, respectively. Assuming 80% of coal ash conversion to fly ash, the fly ash loading to the Petersburg and Harding Street ESPs will be 6.4 and 7.0 lbs/MMBtu, respectively.

In addition to the fly ash loading, the solids from Trona injection and brominated powdered activated carbon (PAC) injection will also be included as a mass loading to the ESP. For purposes of determining FPM emissions, S&L has used approximately 0.2 lb/MMBtu (7.5 lbs/MMacf) of brominated PAC and a solids loading of approximately 0.7 lb/MMBtu from Trona. The Trona loading is about 80% of the total Trona feed because CO_2 and H_2O are liberated as the Trona travels through the flue gas. The specific loss on ignition (LOI) due to unburned carbon (UBC) exiting the boiler was also added to the solids loading to the ESP.

4.3 RESULTS OF 2011 TESTING

IPL performed stack tests at Petersburg Units 2 and 3 and Harding Street Unit 7 in 2011. The tests measured FPM according to EPA Method 5 as identified in the MATS Rule. The tests results showed the three units were below the MATS emission limit. FPM emissions, based on the average of the three test runs are as follows:

- Petersburg Unit 2 - FPM of 0.0085 lb/MMBtu
- Petersburg Unit 3 - FPM of 0.0045 lb/MMBtu
- Harding Street Unit 7 - FPM of 0.0050 lb/MMBtu

These results reflect the ESPs in their existing condition and they were not repaired or overhauled before the testing. Although the 2011 stack test results suggest that FPM emissions from the Big Five Units are below the MATS limit, based on the small size of some of the ESPs and on previous emissions testing, IPL decided to conduct additional testing to understand the mechanism of FPM collection at these three units.

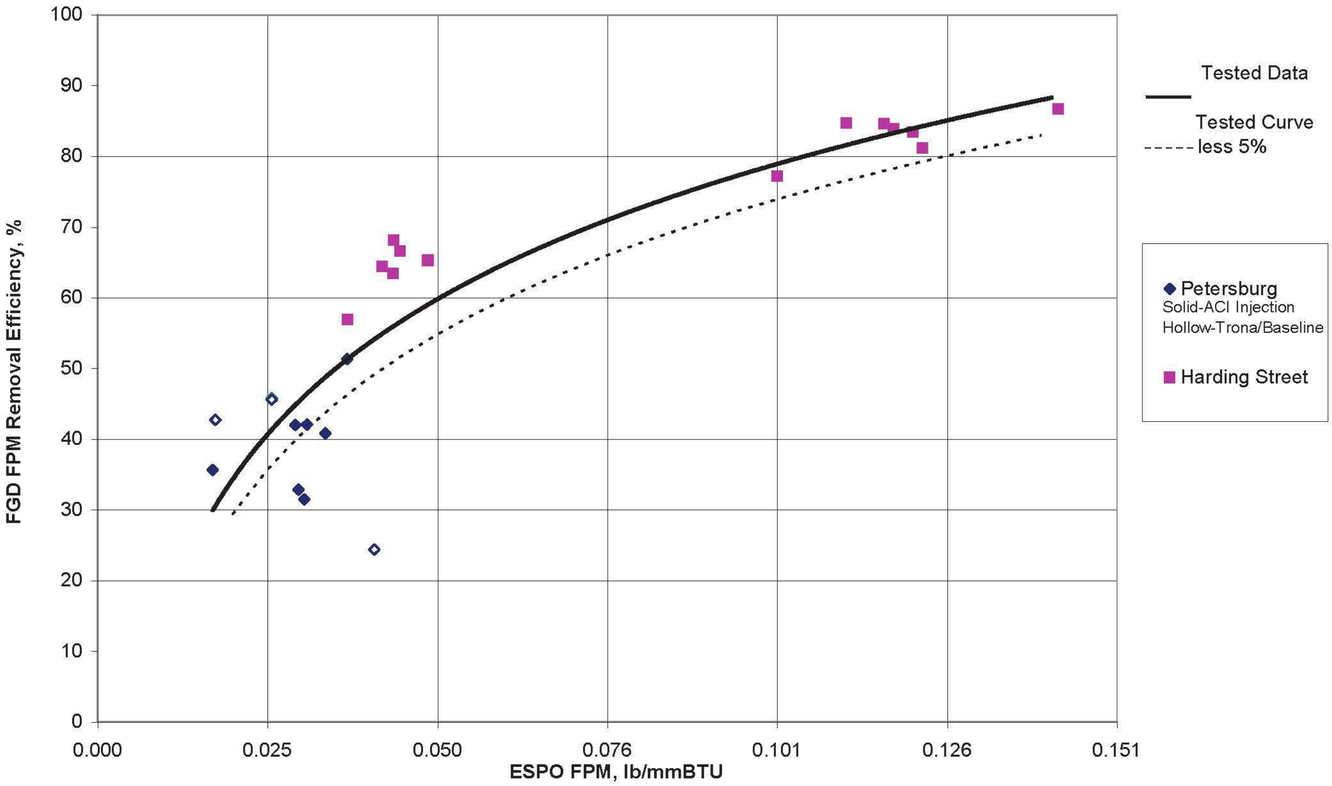
4.4 RESULTS OF DIAGNOSTIC TESTING

At Petersburg Unit 2, stack FPM data were collected from eight runs when Trona and brominated PAC were injected and the average of these runs was 0.018 lb/MMBtu and the range was 0.011 lb/MMBtu to 0.021 lb/MMBtu. At Harding Street Unit 7, FPM data were collected for 10 runs while sodium solution and brominated PAC were injected. FPM emissions during those test runs averaged 0.018 lb/MMBtu and ranged from 0.016 lb/MMBtu to 0.023 lb/MMBtu. These one- to two-hour runs show higher FPM than those in 2011, but test results still suggested that the units were below the MATS FPM limits.

At both Petersburg and Harding Street, FPM control occurs in the ESP and in the wet FGD systems. Because ESPs are a constant-efficiency control device, the coal ash content and fly ash is important in determining ESP outlet emissions. With an ESP, the higher the ESP inlet FPM, the higher the ESP outlet FPM. The FGD system removes particulate solids, but because less is known about the FPM collection efficiency, it is less predictable.

Test results at Petersburg Unit 2 and Harding Street Unit 7 have helped characterize solids removal by the wet FGD systems. Figure 4-1 is an approximation of the FPM removal efficiencies in the Petersburg Unit 2 and Harding Street Unit 7 wet FGD systems based on the testing done in 2012. Generally, the curve shows that between 0.02 lb/MMBtu and 0.14 lb/MMBtu inlet loading to the wet FGD, the wet FGD was removing significant amounts of FPM, between 30% and 90%. These results confirmed the hypothesis that the wet FGD control systems were actually providing significant help in removing FPM emissions below the MATS limits.

Figure 4-1. Petersburg Unit 2 and Harding Street Unit 7 Approximate Solids Removal by FGD



Test data suggest that at wet FGD inlet FPM loadings of less than 0.02 lb/MMBtu, FPM removal efficiencies in the wet FGD rapidly drops, essentially to zero. In S&L's judgment, at these low inlet levels, the wet FGD system does not lower FPM emissions further and that an outlet emission rate between about 0.005 lb/MMBtu to 0.015 lb/MMBtu can be expected. At these low wet FGD inlet FPM emission rates, the absorber and its mist eliminator must have a significant influence in determining the wet FGD outlet FPM emission rate. Accordingly, the stations must adequately maintain the mist eliminators and keep them free from deposits to ensure FPM emissions remain below the MATS limit.

During the diagnostic testing, a sample of the FPM emitted from the chimney was analyzed for sulfates to determine if FPM emissions consisted predominantly of fly ash or FGD solids that were sulfates resulting from the FGD. The analysis showed that Petersburg Unit 2 had <10% sulfates through most of the testing, but on one day, it was between 15% and 50%. Harding Street Unit 7 had <10% sulfates through all testing.

Figure 4-1 illustrates FPM removal efficiency in the wet FGD and allows the prediction of FPM stack emissions. The solid-line curve fit represents a best-fit of the available data. Since there is variability in the test data, a second curve that is 5% lower than the curve fit is also shown in the figure. This curve characterizes the FPM removal efficiency in the wet FGD with high confidence of meeting or exceeding the value. This dotted-line curve was used for calculations of FPM removal efficiency in the wet FGD.

4.5 EVALUATION OF CONTROL EQUIPMENT

Performance of the ESPs in their current condition was predicted, and the FPM removal in the wet FGD was determined based on available test data. The results are shown in Appendix A. The data in Appendix A represent S&L's interpretation of the testing data from Petersburg Unit 2 and Harding Street Unit 7 as well as S&L's projection of the performance of the existing ESPs at Petersburg Units 1-4.

Key characteristic groups of rows are color-coded in Appendix A, with green identifying characteristics that generally are associated with good FPM control and low FPM emissions, and red coloration indicating characteristics associated with poor performance and high FPM emissions. The key characteristics show that the Petersburg Units 2 and 4 ESPs have characteristics of high-performing ESPs and should perform the best and achieve the lowest ESP outlet FPM. Petersburg Units 1 and 3 are moderate performers, while Harding Street Unit 7 is expected to be the worst performer and would have the highest FPM at the ESP outlet.

Performance evaluations at maximum coal ash predict FPM emissions below the MATS limit when as-is condition ESPs are used. Since little data are available with regard to specific testing at the ESP outlet, S&L predicted current performance. Also, the wet FGD control system FPM removal efficiencies shown in Figure 4-1 were considered in the evaluation. The predictions of FPM outlet emissions are provided in Appendix A.

The performance of ESPs in the enhanced condition was predicted using industry-accepted Matts-Ohnfeldt equation. Based on S&L's judgment, the performance of the enhanced ESP and an upgraded ESP (with new internals) would be within 30% of each other with respect to migration velocity. One supplier of ESPs provided the performance data for the Big Five Units when upgraded.

The MATS FPM emissions compliance rate is 0.030 lb/MMBtu, but S&L recommends an emission target of less than 0.025 lb/MMBtu to allow for operating margin. Changing flue gas conditions and coal characteristics, sootblowing, and ESP malfunctions can all cause the FPM to increase, thus, this operating margin is needed. Including an operating or design margin is common practice when sizing FPM equipment. The Petersburg units are operating below 0.025 lb/MMBtu with the existing ESPs. Harding Street Unit 7 ESP is marginal and would need upgrade, as discussed later. The bottom grouping of rows in Appendix A shows the predicted performance for the upgraded ESPs.

Appendix A also has a group of columns that shows two baghouses being added at Petersburg. This is consistent with conclusions from the Hg evaluation (see Section 5 of this report). The baghouses remove FPM emissions below 0.01 lb/MMBtu. However, at these low FPM levels, the wet FGD would not remove additional FPM. In fact, negative values have been used to simulate that the wet FGD actually contributes additional FPM removal. The station-weighted average FPM is well below the emission target of 0.025 lb/MMBtu.

The analysis with one of the lowest FPM emitter in outage shows that the as-is ESPs with FGD can control emissions to a similar level, even with a good-performing unit, e.g., Petersburg Unit 3, off line.

One scenario where the units could be out of compliance is when the wet FGD systems are bypassed due to equipment malfunctions. During such a period, the FPM emissions would be significantly above the MATS emission limit. If the bypass period is short, the short-term FPM excursion will have limited impact on the 30-day average. However, if the control system is bypassed for an extended period, the excursion could cause an exceedance of the MATS limit. The amount of time a unit's FGD system could be bypassed without exceeding the MATS limit was calculated for the Big Five Units, as shown in Table 4-1.

Table 4-1. Big Five Unit Available FGD Offline Hours, FPM Limit

Station-Unit	Projected FPM Emissions without FGD (lb/MMBtu)	Allowable FGD Hours Off Line
Petersburg 1	0.056	135
Petersburg 2	0.036	466
Harding Street	0.067	86

In the case of Harding Street, Unit 7 can bypass the wet FGD for about three days without exceeding the MATS FPM emission limit based on the as-is performance of the ESP. If the ESP is upgraded and performing at or below 0.03 lb/MMBtu, the bypass does not cause an FPM violation for as long as it occurs and the unit would not have to be taken off line until the issue is resolved. The limiting-emission limit during bypass is HCl and is discussed in Section 3 (Compliance with Acid Gases Requirements) of the report.

Projected FPM emissions at the ESP outlet are expected to be highest on Petersburg Unit 1; therefore, bypassing the Unit 1 wet FGD would have the biggest impact on the station. Petersburg Unit 1 could operate in bypass for approximately five days in the as-is condition before FPM emissions exceed the MATS limit on a unit basis. If the Petersburg Station is averaging FPM emissions, the Unit 1 excursion could continue for the entire 30 days without exceeding the MATS limit; however, as the limiting pollutant while bypassing the FGD will be HCl, the wet FGD is absolutely required from MATS compliance.

Petersburg has the option of station-averaging, which increases the number of hours that one of the wet FGDs could be out of service and still meet the FPM limits. With current removal efficiencies, both Petersburg Units 1 and 2 could bypass their wet FGDs for 720 hours and still meet the MATS FPM limits. Note that Petersburg Units 3 and 4 do not bypass the wet FGD during normal operations.

The possibility of ESP performance being poorer than predicted in the enhanced condition was studied. The sensitivity analysis was based on installation of the baghouses on Petersburg Units 2 and 3. It was assumed that the ESP outlet FPM emissions doubled in the case of Petersburg Units 1 and 4 enhanced condition. The expected FGD FPM removal efficiency increased from 58% to 78% for Petersburg Unit 1 and from 46% to 65% for Petersburg Unit 4. The calculated FPM increased from 0.024 lb/MMBtu to 0.025 lb/MMBtu for Petersburg Unit 1 and from 0.019 lb/MMBtu to 0.023 lb/MMBtu for Petersburg Unit 4. There was little change in the station average FPM emissions, indicating that the FPM collection of FGD is expected to mitigate any significant upsets that might occur in the Petersburg Units 1 and 4 enhanced ESPs.

4.6 FPM CONTROL EQUIPMENT OPTIONS

ESP enhancements and upgrades for all of the units can be selected after each ESP is inspected and studied in detail. Typical enhancements and upgrades done within the existing ESP casing include:

- Adding high-frequency power supplies (HFPS) in place of existing TR sets.
- Reducing volumetric flow through the ESP by stopping in-leakage and lowering temperature.
- Enhancing gas distribution to the ESP.
- Further sectionalization of electrical fields in the direction of gas flow.
- Installing magnetic impulse gravity impact (MIGI) rapping systems, which are more reliable than the tumbling hammer rapping systems.
- Replacing weighted wire electrodes with rigid discharge electrodes and at least 12-inch spacing between collecting electrodes.

- At Petersburg Unit 1, there is space to add a field on the front of the ESP and lower outlet FPM emissions.
- At Harding Street Unit 7, the high-velocity is an issue that can be addressed by enlarging the existing ESPs.

The first three enhancements cited immediately above are relatively cost-effective. Installing HFPS can significantly increase FPM removal efficiency at a cost of less than $100,000 per TR set. HFPS are a new technology that has been developed in the last 10 years, and has become a more routinely accepted retrofit upgrade in the last five years.

Retrofitting new ESPs is another control option. Since most of the ESPs can be upgraded within the existing casing, a replacement and expansion is not generally necessary. Petersburg Unit 2 is an exception, as the existing ESP has some significant issues internally and the casing has experienced significant wear such that an in-place replacement may be needed in the near future. Harding Street Unit 7 would benefit from an expanded ESP; however, because the SCR was built over the ESP and restricts access, a complete replacement and expansion is not practical.

A retrofit baghouse is an option for any of the Big Five Units. Baghouses provide the lowest FPM emissions, as the flue gas gets pulled through the baghouse filter cake and the Hg is collected at a high efficiency and at a lower brominated PAC injection rate. Compared to an ESP, a baghouse would also provide greater removal of other non-Hg metal HAPS because of the high efficiency of the filter cake. This could be beneficial in the future if EPA requires additional removal of these HAPS.

4.7 ESP WORK REQUIRED

4.7.1 Petersburg Units 1, 3, and 4

If the Petersburg Station ESPs are to remain in service along side the baghouses, they will require certain enhancements. At a minimum, the activities discussed below will be required as related to the current evaluation. It is expected that other significant enhancements with similar costs will be required every seven years thereafter.

Petersburg Unit 1 has a weighted-wire ESP, which already has undergone retrofit of its MIGI rappers. The approximate costs for the required enhancements are shown in Appendix D, including enhancements to the ESP, ash handling systems, and upgrading eight TR sets with high-frequency power supplies. Specifics of the ESP initial enhancements include:

- Conduct a model study to enhance flue gas flow distribution.
- Add a purge air system.
- Reduce in-leakage of air into the ESP.
- Add hopper heaters and removable insulation.
- Install new weighted-wire discharge electrodes.
- Straighten approximately 5% of plates.
- Reduce flue gas temperatures losses by changing 50% of insulation.
- Enhance ash handling system instrumentation enhance ash handling.
- Perform other miscellaneous work.

Petersburg Unit 3 also has a weighted-wire ESP, which already has MIGI rappers on the CE but vibrators on the DE. The approximate costs for the required enhancements are shown in Appendix D, including enhancements to the ESP and ash handling system. Specifics of the ESP initial enhancements include:

- Conduct a model study to optimize flue gas flow distribution.
- Install new weighted-wire discharge electrodes.
- Add a purge air system.
- Reduce in-leakage of air into the ESP.
- Add hopper heaters and removable insulation.
- Enhance ash handling system instrumentation to enhance ash handling.

The Petersburg Unit 4 ESP has rigid discharge electrodes (RDEs), pipe and spike, and is in reasonable condition, but does have tumbling hammer rappers. The approximate costs for the required enhancements are shown in Appendix D, including enhancements to the ESP, ash handling system, and upgrading 16 TR sets with high-frequency power supplies. Specifics of the ESP initial enhancements include:

- Conduct a model study to optimize flue gas flow distribution.
- Install MIGI rappers to enhance reliability.
- Straighten some collecting plates.
- Install new plates in last two fields because some existing plates are ineffective.

- Install some RDEs.
- Enhance ash handling system instrumentation to optimize ash handling.

4.7.2 Harding Street Unit 7

Harding Street Unit 7 has a weighted-wire ESP and requires upgrading in order to achieve a significant boost in performance and reliability. Potential ESP upgrades are shown in the capital cost estimate provided in Appendix D of this report. However, the ESPs must be evaluated to identify the specific upgrades that are required. One preliminary option is as follows:

- Enlarge the ESP casing to reduce the gas velocity.
- Conduct a model study to optimize flow distribution.
- Expand the height of the ESP casing.
- Remove all ESP internals.
- Install RDEs and collecting plates on a 12" spacing.
- Install all supports and insulators.
- Install MIGI rappers.
- Reduce in-leakage into the ESP.
- Install 20 HFPS.

4.8 CONCLUSIONS

The following conclusions are made based on an evaluation of available stack test data from Petersburg and Harding Street Stations and a review of the existing ESP and wet FGD control systems:

- Diagnostic testing showed that the FGD systems remove significant amounts of the FPM leaving the ESP.
- When the maximum coal ash content is considered at Petersburg, the combination of ESP and wet FGD removes enough FPM that each unit is still projected to have FPM emission below the target emission rate of 0.025 lb/MMBtu and below the MATS level of 0.030 lb/MMBtu.
- If two baghouses are installed at Petersburg for Hg control, the stationwide FPM average emission rate will be below the MATS FPM limit.
- ESPs at Petersburg that will remain as part of the control plan will have to be enhanced to enhance their reliability and internal integrity and brought to maximum performance.
- The Harding Street ESPs will not meet the FPM emissions target of 0.025 lb/MMBtu with SI, ACI, and maximum coal ash content; therefore, these ESPs should be upgraded. This includes new internals and power supplies.

5. COMPLIANCE WITH MERCURY REQUIREMENTS

5.1 BACKGROUND

Mercury (Hg) compliance requirements are discussed in Section 2 (Final MATS Rule) of this report. The final MATS Rule includes an Hg emission limit of 1.2 lbs/TBtu (30-boiler-operating-day average) for individual units, and a 1.0 lb/TBtu (90-boiler-operating-day average) if emissions are averaged. IPL has decided to evaluate compliance with the 1.0 lbs/TBtu limit on a 90-day average for Petersburg, and the 1.2 lbs/TBtu limit on a 30-day average for Harding Street Unit 7. IPL plans to install Hg CEMS to monitor continuous compliance with the applicable limit.

IPL performed stack testing on Petersburg Units 2 and 3 and Harding Street Unit 7 in 2011. The results showed that existing Hg emissions from Petersburg Units 2 and 3 were significantly greater than the MATS limit. The Hg emissions at Harding Street Unit 7 were less than the MATS limit; however, this unit was also firing a fairly low-Hg coal at the time of the test. At both stations, the Hg removal efficiency was less than would be expected on a unit with wet FGD when firing eastern bituminous coal.

In order to understand the mechanism of Hg reduction and to develop confidence in a control plan to meet the MATS emission limits, IPL performed diagnostic testing in 2012 on Petersburg Unit 2 and Harding Street Unit 7. The mechanism of Hg control was determined to relate to air heater gas outlet (AHGO) temperature, oxidation level of the Hg, and whether the FGD system re-emits Hg. If brominated PAC is injected, the mechanism of Hg control relates to the available residence time in the flue gas stream, size of the ESP, concentration of SO_3, and AHGO temperature.

The results of this evaluation also indicate that Hg emissions are a strong function of the Hg in the coal and the control technologies employed. There are three groups of coal in the IPL coal mix and each has a different control technology need. The three groups are:

- Indiana coal having Hg ≤ 8 lbs/TBtu maximum 90-day average, and need 85% to 90% Hg removal. The Hg control strategy for low-Hg coals could be as simple as oxidizing the Hg with a fuel additive and allowing the FGD to collect the oxidized Hg.

- Indiana coal having Hg ≤ 9 lbs/TBtu average, and need 85% to 90% Hg removal. The Hg control strategy for medium-Hg coals could be to remove Hg before the FGD using activated carbon, and allow the FGD to remove a small amount of Hg.
- Indiana coal having Hg ≤11.2 lbs/TBtu, and need 90% to 95% Hg removal. The Hg control strategy for these coals could be to remove Hg before the FGD using activated carbon, and allow the FGD to remove a small amount of Hg.

Research of nationwide data on the Hg content of coal indicates that Indiana coals found in the Illinois Basin are among the lowest in Hg content in the U.S. The Hg content of the coals sourced from the major coal-producing regions in the U.S. is summarized in Table 5-1.

Table 5-1. Summary of Hg Content of Coals Sourced from Major U.S. Regions

Region	Hg Range (lbs/TBtu)
Illinois Basin	5 – 10
Colorado Basin	5 – 10
Powder River Basin	10 – 15
Central Appalachia	10 – 15
Northern Appalachia	15 – 20
Western Interior	15 – 20
Texas and Gulf Coast	>20

Since most coals in the U.S. are either higher in Hg and/or sourced farther from the stations, switching to other coals from outside southwestern Indiana is not an option for achieving compliance with MATS.

Any of the above three Hg control plan options are viable, depending on the station under consideration. The remainder of this section evaluates how these fuels and control technologies can be used to achieve compliance with MATS at Petersburg and Harding Street.

The following topics, as related to Hg compliance are discussed below.

- Coal basis
- Results of 2011 testing
- Results of diagnostic testing
- Evaluation of control equipment
- Hg equipment options
- Conclusions

5.2 COAL BASIS

Coals fired at Petersburg in the last five years (2007-2011) were evaluated based on quarterly averages to identify the average and maximum as-received Hg contents. The quarterly period (approximately 90 days) was used because the compliance period is 90 days (when averaging emissions) and historical data are available only on a quarterly basis. The quarterly Hg content of coal fired at Petersburg is determined by sampling a shipment of coal from each mine each calendar quarter, and running a complete ash mineral trace metals analysis. Quarterly values indicate that the coal received could be characterized as having a maximum Hg content of 11.2 lbs/TBtu (quarterly average over a five-year period). Evaluation of this maximum determined that it represents a reasonable maximum value for Petersburg in the future. Currently, the coals that are closest to Petersburg Station, which, generally are the least-cost coals, have the highest Hg content when compared with other coals in southwestern Indiana also burned at Petersburg. Therefore, the evaluation used 11.2 lbs/TBtu as the maximum Hg coal content, which should be expected for Petersburg. Since compliance with the MATS limit will be measured on a 90-day rolling average basis (when averaged emissions from more than one unit), an Hg content of 11.2 lbs/TBtu is used as the design coal for Petersburg.

The coals fired at Harding Street Unit 7 primarily are from the mines in the northern portions of the southwest Indiana coal region. Some of those mines produce coal with low Hg (<6 lbs/TBtu) content and others with medium Hg (<9 lbs/TBtu) content. For Harding Street, coal with a maximum Hg content of 9 lbs/TBtu was selected based on the mines that are low-cost providers to the station. Although this maximum Hg content is considered high for the coals Harding Street typically receives, this value does provide for fuel flexibility should the low-Hg mines not be available in the future.

5.3 RESULTS OF 2011 TESTING

IPL performed stack tests in 2011 on Petersburg Units 2 and 3 and Harding Street Unit 7, and measured Hg emissions using EPA Method 30B. Three test runs were completed on each unit and the average results are as follows:

- Petersburg Unit 2 - Hg emissions of 7.73 lbs/TBtu with coal Hg of 10.6 lbs/TBtu, for a removal efficiency of 27%.
- Petersburg Unit 3 - Hg emissions of 2.45 lbs/TBtu with coal Hg of 7.9 lbs/TBtu, for a removal efficiency of 69%.
- Harding Street Unit 7 - Hg emissions of 1.02 lbs/TBtu with coal Hg of 4.2 lbs/TBtu, for a removal efficiency of 75%.

The Petersburg Unit 2 results showed very low Hg removal efficiency compared to the 70% to 90% removal generally seen from FGD systems on plants firing eastern bituminous coals. The Petersburg Unit 2 FGD was suspected of re-emitting Hg. Re-emission is a phenomenon that has been identified in some utility wet FGD systems, where the oxidized Hg collected in the FGD is chemically reduced back to elemental Hg. The elemental Hg, which is not water soluble, exits the FGD slurry as gaseous Hg and is re-emitted back into the flue gas. Re-emission was also observed at Petersburg Unit 2 in 2006 testing, when IPL tested several additives to eliminate re-emission.[3]

The Hg removal efficiencies measured at Petersburg Units 2 and 3 and Harding Street Unit 7, along with the low chlorine content of coals fired, indicate that Hg in the flue gas is not being oxidized, and, therefore, the Hg is not being captured in the FGD. Re-emission is not suspected to be significant at Petersburg Unit 3; however, FGD inlet and outlet Hg measurements are needed to demonstrate the lack of re-emission.

Because of the uncertainty of the Hg removal, oxidation level, and re-emission, IPL conducted additional testing to diagnose the mechanism of Hg collection.

5.4 RESULTS OF DIAGNOSTIC TESTING

Several issues were resolved by the diagnostic testing, as discussed below, first for Petersburg Unit 2 and then for Harding Street Unit 7.

5.4.1 Petersburg Unit 2 Hg Testing

Diagnostic testing confirmed that re-emission was occurring at Petersburg Unit 2. Elemental Hg exiting the FGD was greater than the FGD inlet Hg. It was also confirmed that fuel additives could be used at Petersburg Unit 2 to increase the oxidation level of the Hg in the flue gas. The Hg oxidation at Petersburg Units 2 ranged between 60% and 80% due to the coal's chloride content, but increased to a range of 85% to 92% with the fuel additive.

It was determined that brominated PAC could effectively remove Hg from the flue gas; however, the Petersburg Unit 2 Hg removal efficiency maximized at 87.5% at a brominated PAC injection rate of 7.5 lbs/MMacf. This is a high rate for brominated PAC injection compared with rates at installed ACI systems. As discussed in more detail below, a higher rate may be necessary in order to reduce capital expenditures.

The high Hg removal efficiency occurred at AHGO temperatures of between 350°F to 380°F. Although the brominated PAC was able to effectively capture Hg, these are high temperatures to inject brominated PAC. S&L recommends that the station work to reduce the AHGO below 350°F, when feasible, as this will allow brominated PAC to capture Hg at a lower brominated PAC feed rate.

When brominated PAC was injected, it was determined that oxidized Hg accounted for 55% of the total Hg at the FGD inlet. This suggests that brominated PAC was removing significant quantities of Hg, and was important in determining if the wet FGD will effectively reduce Hg after the brominated PAC removes most of the Hg.

The Hg concentration in the FGD blowdown steadily decreased when brominated PAC was being used to collect Hg before the FGD. It is hypothesized that two events were occurring. First, the amount of Hg entering the FGD was significantly reduced because brominated PAC was collecting about 80% of the Hg. Reducing Hg loading to the FGD was lowering the Hg concentration in the recycle slurry. Second, the coal Hg content was lowered with the test coal, which would also reduce Hg loading to the FGD and lower the Hg concentration in the recycle slurry. In any event, when using brominated PAC to capture Hg, Hg is being collected by the primary PM control device and ultimately sent to the solids landfill. It is not sent to the FGD blowdown or to the wastewater pond. Using brominated PAC with ESPs or baghouses will collect the Hg before the FGD and reduce Hg in the blowdown. A calculation of the quantity of Hg that could be captured in the FGD systems versus the quantity that could be taken out by brominated PAC injection indicates that the Hg in the FGD blowdown to the pond could be reduced to

[3] Blythe, Gary M., "Field Testing of a Wet FGD Additive for Enhanced Mercury Control - Task 3 Full-scale Test Results, Topical Report, prepared for National Energy Technology Laboratory, March 2007.

approximately 10% or 30% of its current value when brominated PAC is being injected. A more detailed study is needed to accurately predict the reduction in Hg concentration in the blowdown stream. The reduction of Hg in the blowdown is beneficial, but it is likely not enough of a reduction to lower the capital cost of wastewater treatment. This is true whether a baghouse or ESP is the eventual FPM control device.

The test results also measured the Hg concentrations in the gypsum. Review of these test results indicated that the gypsum analyses essentially were unchanged during the testing. No increase in Hg in the gypsum was noticed. Since Hg was taken out of the flue gas stream ahead of the FGD, it is reasonable to expect the gypsum will not have increased Hg. Also, because 95% to 98% of the carbon is being collected in the ESP, it is also reasonable to expect that little brominated PAC is reaching the FGD.

5.4.2 Harding Street Unit 7 Hg Testing

The Harding Street Unit 7 results were similar to the Petersburg Unit 2 results, with the differences summarized below.

- There was no Hg re-emission identified at Harding Street Unit 7.
- Fuel additives did oxidize the Hg, but Hg oxidization was limited to about 75%, which is less than at Petersburg Unit 2. The sodium solution used to control SO_3 at Harding Street Unit 7 might have had an impact on Hg oxidation but this will need to be studied in more depth. If ACI is recommended, brominated PAC will be used and the oxidization effect of the fuel additive is of less importance.
- It was confirmed that brominated PAC could be effective at collecting Hg. Harding Street Unit 7 Hg collection efficiency was high at brominated PAC injection rates between 2 lbs/MMacf and 4 lbs/MMacf brominated PAC feed rate. In S&L's judgment, the lower flue gas temperature at the brominated PAC injection point provided a significant benefit and kept the brominated PAC feed rate low. Another benefit of lower temperature was that because the 4% LOI of unburned carbon was probably acting to collect significant quantities of Hg, less brominated PAC was needed.

Results of Hg in the FGD blowdown tests also differed between Petersburg Unit 2 and Harding Street Unit 7. The Hg concentration in the Harding Street Unit 7 FGD blowdown actually increased rather than decreased. In S&L's judgment, it should have decreased because Hg was being taken out ahead of the FGD. S&L hypothesizes that the first part of testing attempted to collect Hg in the FGD with fuel additives, and that Hg capture in the FGD did increase. In the last three days of testing, we used brominated PAC and it may have taken time for the FGD to blow down the additional Hg captured during the first portion of the testing. In general, S&L's judgment is that because less Hg is present in the FGD inlet when brominated PAC is used, there should be less in the FGD blowdown stream.

5.4.3 Consideration of Measurement Error

S&L used the March 2012 test data to characterize the Hg removal efficiency for Petersburg Unit 2 and Harding Street Unit 7 to define a combined efficiency of the ACI and wet FGD Hg removal performance. A value of 2.5% was selected to represent the error in emission measurements for the ESP outlet efficiencies resulting from the brominated PAC injection that can result from the testing inaccuracies that occur with the limited data collection practical with a temporary injection test configuration. This value is subtracted from an average efficiency value measured. S&L believes that using the test data without this correction, would have a greater chance of over-predicting performance.

5.5 EVALUATION OF CONTROL EQUIPMENT

5.5.1 Evaluation Basis

Total Hg stack emissions were predicted for the Big Five Units. The basis of the prediction is as follows:

- Coals with 6, 8, 9, 10, 11.2 (the selected maximum Hg coal), 12, and 14 lbs/TBtu are included in this evaluation.
- The Petersburg Unit 2 and Harding Street Unit 7 test results are used as the basis for selection of Hg removal efficiency at both units.
- S&L characterized the Petersburg Unit 2 and Harding Street Unit 7 removal efficiencies as the average of the tested values minus measure error.
- The Hg removal efficiency for Petersburg Units 1, 3, and 4 are based on S&L adjustments of efficiencies from the test results.
- The recommended Hg emission target for Petersburg is 0.9 lb/TBtu measured on a 90-boiler-operating-day average to meet a 1.0 lb/TBtu compliance emission limit.
- The recommended Hg emission target for Harding Street Unit 7 is 1 lb/TBtu measured on a 30-boiler-operating-day average to meet a 1.2 lbs/TBtu compliance emission limit since more margin is needed when a shorter averaging time is used.
- The evaluation included some additional emissions due to potential Hg re-emission at Petersburg Unit 2.

5.5.2 Selected Hg Removal Efficiencies for Each Unit

With regard to S&L's selection of Hg removal efficiencies, the following characteristics were considered:

- Units with AHGO temperatures less than 300°F will have higher Hg removal efficiencies and consume less brominated PAC when ACI is used for Hg control. Units with 325°F will have slightly less removal efficiency and units with greater than 350°F will require significantly more brominated PAC to achieve high Hg removal.
- Units with more flue gas path ahead of the ESP will generally have higher Hg removal efficiencies because the brominated PAC will have longer time to react.
- Units with larger SCA ESPs generally have higher Hg removal efficiencies and will allow greater brominated PAC feed rates without impacting FPM emissions.
- Re-emission will lower the removal efficiency because a portion of the captured oxidized Hg is re-emitted.

The multi-step step process used to determine Hg removal efficiency for the Petersburg and Harding Street units is described below. Because minimal Hg is removed in the combustion process, it is expected that all of the coal Hg is in the flue gas.

The first step was to select ACI efficiency based on empirical data. The amount of Hg to the wet FGD is based on ACI removal efficiency and on the coal Hg content. The brominated PAC used in the diagnostic test has a characteristic of 55% of the Hg to the wet FGD being oxidized. This is important because the wet FGD removes only oxidized Hg.

The second step was to select the wet FGD removal efficiency. This evaluation used 90% removal of the oxidized Hg and 0% removal of elemental Hg. The combination of these two removal efficiencies gives the overall Hg removal efficiency. For example, if ACI removes 80% Hg from an 11.2 lbs/TBtu inlet Hg coal and the wet FGD removes 90% of the oxidized Hg, the overall removal efficiency is 90%.

The case of Petersburg Unit 2 involved a third step in the process because this unit exhibits re-emission. The amount of re-emission is 50% of the oxidized Hg that was collected. Using the above example as the basis, 90% overall Hg removal would be reduced to 85% due to the re-emitted Hg.

Table 5-2 summarizes the calculated Hg removal efficiency values for the Big Five Units.

Table 5-2. Calculated Hg Removal Efficiencies for Big Five Units

Hg Removal Efficiency (%)	Petersburg 1	Petersburg 2	Petersburg 3	Petersburg 4	Harding Street 7 (300°F)	Harding Street 7 (325°F)
ACI + ESP	85	86	76	78	90	83.5
Overall (ACI + ESP + FGD)	92	93	88	89	95	92
Reduced overall due to re-emissions impact	N.A.	89	N.A.	N.A.	N.A	N.A.

Retrofitting a baghouse with ACI is expected to provide an Hg removal efficiency of at least 90% and the FGD then removes 90% of the oxidized Hg, for an overall Hg removal efficiency of 95%. If there is presence of re-emission, that amount is deducted from the overall efficiency.

5.5.3 Petersburg Unit 2 Hg Evaluation

The removal efficiency used for Petersburg Unit 2 is 89% with the measurement error included in the calculation. This removal is based on Trona injection ahead of the air heater and reducing SO_3 before the brominated PAC injection location. The brominated PAC injection was located about one second downstream of the air heater and at least two seconds ahead of the ESP. This residence time was sufficient for the brominated PAC to be effective. During the 2012 testing, the Petersburg Unit 2 FGD exhibited significant re-emission of captured Hg. S&L adjusted the Hg removal efficiency to include this re-emission tendency. A value of 50% re-emission is included.

5.5.4 Harding Street Unit 7 Hg Evaluation

The removal efficiency used for Harding Street Unit 7 is 95% with the measurement error included in the calculation. This removal is based on the existing SBS system removing SO_3, brominated PAC being injected ahead of the ESP, and the FGD removing oxidized Hg at 90% level. This unit has low AHGO temperatures, which makes the brominated PAC especially effective at capturing Hg. The unit also has about 4% LOI, which S&L believes is also removing a significant portion of Hg, similar to brominated PAC, lowering the amount of brominated PAC needed. At Harding Street Unit 7, the brominated PAC was injected ahead of the air heater, which gave the brominated PAC enough residence time to be effective. Because Hg re-emission was not occurring at this unit, the oxidized Hg collected in the FGD remained with the recycle slurry.

5.5.5 Petersburg Unit 1 Hg Evaluation

Removal efficiency for Petersburg Unit 1 was selected based on the data collected at Harding Street Unit 7. The last day of testing at Harding Street Unit 7 had the AHGO temperature artificially raised to about 325°F to be close to the Petersburg Unit 1 AHGO temperature. S&L selected an Hg removal efficiency of 92% for Petersburg Unit 1, which is lower than the Harding Street Unit 7 efficiency because of the higher Petersburg Unit 1 AHGO temperature. Sorbent injection (SI) equipment will be used at Petersburg Unit 1, with Trona injected ahead of the air heater, brominated PAC injected several seconds ahead of the ESP, and the wet FGD. Petersburg Unit 1 has approximately 4% LOI, which should capture some Hg and reduce the brominated PAC feed rate. The ESP is smaller at Petersburg Unit 1, but the added residence time and the lower temperature make the smaller SCA less of a concern. The FGD system showed close to 77% Hg removal in 2006 testing. In S&L's judgment Petersburg Unit 1 was not exhibiting re-emission and S&L did not include re-emission in the determination of Hg removal efficiency.

5.5.6 Petersburg Unit 3 Hg Evaluation

For Petersburg Unit 3, an Hg removal efficiency of 88% was selected. This unit has high AHGO temperatures, similar to those at Petersburg Unit 2, but because the residence time is less for Petersburg Unit 3, the ACI removal efficiency will be less. Another concern is that Petersburg Unit 3 has a smaller ESP than does Petersburg Unit 2, which will limit the removal efficiency that can be achieved with ACI. The 2007 Hg removal efficiency was 66%, with low-chlorine coal (300 ppm). The 2011 stack testing at Petersburg Unit 3 demonstrated a similar Hg removal efficiency. In S&L's judgment, Petersburg Unit 3 was achieving low Hg oxidation and was not exhibiting re-emission; thus, S&L did not include re-emission in the determination of Hg removal efficiency.

5.5.7 Petersburg Unit 4 Hg Evaluation

For Petersburg Unit 4, an Hg removal efficiency of 88% was selected. This unit has high AHGO temperatures, similar to those at Petersburg Units 2 and 3. The flue gas path for Petersburg Unit 4 is such that there is limited duct length ahead of the ESP, and brominated PAC injection will need to be either just ahead of or just downstream of the air heater. SI using Trona will be installed in the economizer outlet to reduce SO_3 before the ACI. The Petersburg Unit 4 ESP is close in size to that of the Petersburg Unit 2 ESP, which will help with Hg removal. Hg removal measured during the 2007 stack test was 56%, but there was 6% to 10% of flue gas bypassed around the FGD during the test. When this is factored in and the FGD Hg removal efficiency re-calculated, the efficiency was closer to 65%. The FGD system showed close to 65% Hg removal during the 2007 test, which was on a very low-chloride coal (200 ppm). In S&L's judgment, Petersburg Unit 4 was achieving low Hg oxidation and was not exhibiting re-emission; thus, S&L did not include re-emission in the determination of Hg removal efficiency.

5.5.8 Predicted Hg Emissions for the Big Five Units

Appendix B provides a detailed presentation of the predicted total Hg emissions for the Big Five Units based on coals with various Hg contents. The data were developed to represent the likely combinations of coal Hg and control technologies and are based on the Hg removal efficiencies discussed above. Predictions provided in Appendix B show the expected Hg emissions for each unit as well as the station average for Petersburg, based on 90-boiler-operating-day period and full-load operations of all units during that period. Also shown is a station average when one of the large, low-Hg emission rate, units is off line for the entire 90-day period. Appendix B will be used to evaluate fuel and emissions control technology combinations.

5.5.9 Uncertainties

Uncertainties in the above Hg analyses are discussed below.

Testing indicated no re-emission at Harding Street Unit 7, but similar testing at Petersburg Unit 2 indicated strong re-emission. We do not have tests at the other units to determine the presence of re-emission. The determination of the presence of re-emissions on a unit is more important if the unit has less than 90% Hg removal efficiency. Units with greater than 90% Hg removal have limited Hg reaching the FGD and there is less Hg in solution to be re-emitted. If IPL decides to fire coals of 11 lbs/TBtu or greater, re-emission becomes more important.

Actual data for Petersburg Unit 2 and Harding Street Unit 7 were used for removal efficiency predictions, reducing the possibility of a significant error in characterizing their removal efficiency. Data collected at similar temperatures were used, reducing the risk of error in characterizing Petersburg Unit 1.

Lowering the AHGO temperature on Petersburg Unit 2-4 will enhance the effectiveness of brominated PAC. At medium and low loads, the lower temperature is expected to reduce the PAC feed rate needed to maintain Hg removal efficiencies. Temperatures above 350°F will require the baghouse suppliers to use woven fiberglass bags with PTFE membrane. These are more costly and there is less experience with these bags.

5.6 HG CONTROL EQUIPMENT OPTIONS

S&L has identified several available control scenarios for reducing Hg emissions at the Petersburg and Harding Street stations. These possible generic Hg reduction scenarios are as follows:

- **Scenario 1**. Reduce the Hg in the fuel being fired and rely on the existing FGD systems to remove Hg.
- **Scenario 1a**. Implement Scenario 1 along with fuel additives to further oxidize Hg to enhance the efficiency of the FGD systems.
- **Scenario 1b**. Implement Scenario 1 along with FGD additives if an FGD is re-emitting.
- **Scenario 2**. Install SI[4] and ACI equipment ahead of the wet FGD, use SI (Trona or SBS) to reduce SO_3 to allow the brominated PAC to capture Hg, collect the SI and brominated PAC in the existing ESP, and rely on the wet FGD to capture additional Hg that is not removed by the brominated PAC.
- **Scenario 3**. Install SI, ACI, and baghouse equipment ahead of the FGD to capture Hg, or collect the brominated PAC in the existing ESP, and rely on the FGD to capture additional Hg that is not removed by the brominated PAC.

Under Scenario 1, the Hg content of the coal could be, theoretically, limited to no more than 5 lbs/TBtu with 90% Hg oxidation and 90% Hg removal of oxidized Hg in the FGD system, which would result in an 81% overall Hg removal efficiency. If an SCR is available to oxidize additional Hg, the FGD is very efficient, and conditions are optimal, an overall Hg removal efficiency of 85% would be expected, which would mean a 6.6 lbs/TBtu coal could be fired. IPL does have some coals with Hg contents of 6.6 lbs/TBtu or less in its current portfolio. As Harding Street currently receives some low-Hg coal, Scenario 1 could be a viable option for Unit 7. However, the design basis is 9 lbs/TBtu Hg coal; therefore, Scenario 1 would not provide the desired fuel flexibility.

With Scenarios 1a and 1b, overall Hg removal efficiencies in the range of 81% to 85% are expected, and additives are available to help overcome oxidation limitations and/or re-emission problems. However, these scenarios are not well demonstrated, rendering Scenario 2 the lower-risk option.

Scenario 2 (SI and ACI ahead of the existing ESP) potentially has a Hg removal efficiency as high as 95%, but in practical terms the limit would be closer to 85% to 90%. With these removal efficiencies, coals with up to

[4] In this report, the term *sorbent injection* (SI) refers to injections of a solution or dry powder to react with SO_3 in the flue gas. The industry commonly uses the term *dry sorbent injection* (DSI) to refer to this technology.

10 lbs/TBtu are possible for the unit. Conditions at the unit must be favorable, as listed below, to exceed 90% removal with this approach.

- AHGO temperatures of 300°F and below.
- Residence time to allow SI to react with SO_3 before the brominated PAC is injected (0.5 second).
- Residence time to allow the brominated PAC to adsorb the Hg (0.5 to 2 seconds).
- LOI can act like brominated PAC, but it is not as effective.
- The wet FGD will collect much of the oxidized Hg that is not collected by the brominated PAC and 3% to 5% more efficiency.

Under Scenario 3, SI and ACI used in conjunction with a baghouse, Hg removal efficiencies in the range of 95% are possible, with minor additional collection in the FGD. The baghouse gives the highest collection efficiency because of the brominated PAC in the filter cake on the surface of the bags. Flue gas must pass through the baghouse filter cake, where additional mercury will be adsorbed by the activated carbon. Hg removal efficiency in the baghouse is dependent on temperature and residence time, though not to the extent as the ESP under Scenario 2. Brominated PAC and a baghouse have shown Hg removal efficiencies as high as 95%, but only under favorable conditions. With ACI efficiency at 90%, wet FGD can add 3% to 5% to the total Hg removal efficiency.

There are claims that some additives are more effective than brominated PAC, though none have been demonstrated to the same extent as brominated PAC. Some sorbents are claimed to remove SO_3 efficiently, but none have been demonstrated more effective than Trona, hydrated lime, or other sodium compounds. There are other processes that are claimed to be more effective than the scenarios above, but have not been demonstrated. Therefore, the above Scenarios 1 and 3 are put forth for IPL's consideration for its emissions control plan.

Each of the Big Five Units can achieve compliance with the MATS Hg emission standard using any one of the above scenarios. The scenarios include limits on the Hg in the coal or adding Hg control technology. In order for IPL to make an informed decision as to which scenario to implement, an economic model is required to evaluate the cost of each scenario. An economic evaluation is presented later in this report.

5.7 CONCLUSIONS

The evaluation of MATS Hg compliance options for the Petersburg and Harding Street stations concluded the following:

- There are available technology and coal options that allow IPL to comply with MATS Hg limits.
- If Hg content in the coal remains at historical values (11.2 lbs/TBtu), Hg compliance is possible with one to three baghouses at the Petersburg Station.
- Based on Hg content in the coals expected to be used at Harding Street Unit 7, Hg control compliance is possible with an enhanced ESP.
- Selection of the combinations of ESPs and baghouses will be driven by fuels costs, capital costs, and O&M costs.

The economic analysis in Section 9 of this report compares the economic impact of the various Hg control compliance scenarios.

6. 2011 COMPLIANCE TESTING

Upon issuance of the proposed Utility MACT Rule in March 2011, IPL contracted for stack testing at Petersburg Units 2 and 3 and Harding Street Unit 7. This testing was designed to measure existing HAP emissions from the units for comparison with the proposed Utility MACT Rule. The final MATS Rule retained the same emissions limits on acid gases and Hg, but the compliance demonstration methodology for the non-Hg HAP metal limits was revised. Data from the 2011 stack tests were helpful, and were used to compare existing HAP emissions from the units with the emission standards in the final MATS Rule.

7. 2012 DIAGNOSTIC TESTING

Upon issuance of the final MATS Rule, it was decided that the Big Five Units had reasonable potential of compliance without a baghouse at each unit, which would provide significant cost savings. To determine potential Hg and FPM emissions of each of the Big Five Units, it was determined that some testing was needed. Petersburg Units 2-4 had higher flue gas temperatures than are ideal for Hg capture using ACI. Re-emission of Hg at Petersburg Unit 2 was known to occur and its presence needed to be investigated. The ESPs at all five units were suspect with regard to complying with the FPM limits. The contribution of the FGD to Hg removal and FPM removal needed to be investigated. Testing was completed March 9-15, 2012 at Petersburg Unit 2 and March 9-24, 2012 at Harding Street Station Unit 7.

Clyde Bergemann was contracted to provide testing services. The firm supplied temporary SI and ACI equipment, subcontracted to Grace to perform flue gas testing, coordinated the testing, and sent water samples, gypsum samples, and coal samples to the lab for analysis. Also, Nalco was contracted to provide fuel additive and analysis of results.

The results of testing were used as described in Sections 3, 4, and 5 of this report. The Hg removal efficiencies, oxidations levels, FPM removal efficiencies, and other calculations were quantified based on the results of testing. A summary of the 2012 diagnostic testing is provided in Appendix C. Appendix H presents the 2012 testing protocol.

8. ESTIMATED COSTS FOR COMPLIANCE OPTIONS

The approach taken in this study was to estimate the capital and annual O&M costs for all the possible options to comply with MATS. Next, the net present value revenue requirements (NPVRR) for each option was determined based on the capital and O&M costs. Since changing to a lower-Hg coal was an option for Petersburg Station, the cost of switching to a lower-Hg fuel was included in the NPVRR for each option. The total NPVRR for capital, annual O&M, and fuel were then compared for the combination of options that would lead to MATS compliance. The low NPVRR cost and options were considered in more detail and a final combination of options for the units was recommended as the environmental control plan for the Big Five Units. This evaluation is discussed in Section 9, with the capital and annual O&M costs that are a part of the evaluation discussed in this section.

8.1 CAPITAL COST ESTIMATE

Capital costs were estimated in detail for the Petersburg Units 2 and 3 baghouse retrofit options. Based on initial cost estimates and analysis, it was determined that these two units were most likely to receive new baghouses, with the attendant cost of retrofit significantly more than the cost of upgrading or enhancing an existing ESP that is in acceptable structural condition. Table 8-1 summarizes the Petersburg Units 2 and Unit 3 baghouse retrofit capital costs.

Table 8-1. Petersburg Units 2 and 3 Baghouse Retrofit Capital Cost Estimate Summary

Cost Description	Pete Unit 1 -w- Existing ESP	Pete Unit 2 -w- New Baghouse	Pete Unit 3 -w- ESP & Polishing Baghouse	Pete Unit 4 -w- Existing ESP	HSS Unit 7 -w- Existing ESP
Capital (Equipment, Material & Labor)					
New Assets					
BH	NA	28,614,000	29,779,000	NA	NA
ESP Upgrades	950,000	NA	NA	1,750,000	24,500,000
Ductwork	NA	13,649,000	18,280,000	NA	5,300,000
Steel (Excluding Ductwork)	2,000,000	13,801,000	10,730,000	2,000,000	2,600,000
Fans	-	4,891,000	5,029,000	-	-
SI	3,070,000	3,315,000	3,360,000	3,890,000	400,000
ACI	1,230,000	1,182,000	1,357,000	1,620,000	1,200,000
CEMS (1.5 M per Stack system incl. Hg, HCL, FPM)	4,900,000	4,900,000	2,450,000	2,450,000	4,700,000
Electrical Equipment	600,000	5,249,000	6,869,000	600,000	600,000
BOP (Electrical, Air, Demo, Etc.)	4,823,000	28,970,000	21,030,000	3,660,000	4,000,000
BOP (Demo)	400,000	3,590,000	2,199,000	450,000	1,200,000
WFGD Upgrades	2,700,000	2,700,000	NA	NA	500,000
Relocation of Unit 3 BH to Flood Plain	-	-	NA	NA	NA
Other Direct and Const Indirect	4,842,000	29,738,000	27,639,000	3,846,000	10,539,000
Indirect Cost	3,876,100	15,466,000	14,159,000	3,613,100	6,109,000
Total Escalation	1,704,000	7,405,000	8,322,000	1,384,000	3,573,000
Total Contingency	6,064,000	20,661,000	19,436,000	4,899,000	12,330,000
Subtotal New Assets	37,159,100	184,131,000	170,639,000	30,162,100	77,551,000
Enhancements of Existing Assets					
ESP Enhancements	3,600,000		1,695,000	5,400,000	
Reduce Air Inleakage from Ducts	1,575,000	2,048,000	1,337,000	1,400,000	2,800,000
Reduce Air Inleakage from Fans	438,000	-	-	438,000	0
Subtotal Enhancements of Existing Assets	5,613,000	2,048,000	3,032,000	7,238,000	2,800,000
Total Project Costs	43,000,000	186,000,000	174,000,000	37,000,000	80,000,000

These two estimates are conceptual-level estimates and are based on less than 2% of the project being defined. The Petersburg Unit 2 and Unit 3 capital cost estimates can be classified between Class 5 and 4 estimates, according to the Association for Advancement of Cost Engineering (AACE), as illustrated in Table 8-2. The estimate includes slightly under 15% contingency to cover unknowns because the minimal level of project definition, less than 2%. In S&L's judgment, the accuracy of the Petersburg Units 2 and 3 estimates is ±20%.

Table 8-2. AACE Generic Cost Estimate Classification

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

Notes: [a] If the range index value of "1" represents +10/-5%, then an index value of 10 represents +100/-50%.
[b] If the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Compared to the Units 2 and 3 estimates, the baghouse cost estimates for Petersburg Units 1 and 4 and for Harding Street Unit 7 reflect a lesser degree of project definition, less than 1%. The Petersburg Units 1 and 4 and Harding Street Unit 7 cost estimates shown in Appendix D were factored off of the Petersburg Units 2 and 3 estimates and include 20% contingency for unknowns. These capital cost estimates have ±20% accuracy for Petersburg Units 2 and 3 and ±35% accuracy for Petersburg Units 1 and 4 plus Harding Street 7 and would be considered a Class 5 ACEE cost estimate.

The capital cost estimates for the ESP options, also shown in Appendix D, were based on minimal project definition because internal inspections have not been completed and documented in the last year. These estimates include a 20% contingency for unknowns and have ±35% accuracy.

Appendix D provides a description and cost summary of each option.

8.2 ANNUAL COSTS

Annual O&M costs developed for the Big Five units are presented as first-year (2012 dollars) and shown as cost adders to the current station annual cost. Costs are shown as fixed and variable O&M values. Fixed costs include operating labor, maintenance labor, and maintenance materials. Variable costs encompass SI sorbent (Trona or hydrated lime), ACI adsorbent (brominated PAC), and power consumption. SI costs for SO_3 reduction are based on Trona as the sorbent for ESP applications and on hydrated lime as the sorbent for baghouse applications at Petersburg. SBS is used as the sorbent for Harding Street. These annual costs for SI and ACI were developed based on prorating the performance of Petersburg Unit 2 and Harding Street Unit 7 during diagnostic testing described in other sections of this report.

Variable costs for the baghouse installations include replacement of the bags every four years; thus, one-fourth of the total bag replacement cost is shown in the first year. Power consumption for the baghouse is increased since the baghouse and new ductwork create added draft loss that the ID and booster fans need to overcome. The cost of fly ash disposal is shown for the Petersburg Units 3 and 4 ESP options when PAC and Trona contaminate the fly ash and make the ash unsaleable. Variable costs are calculated at a 79% capacity factor for all units.

The annual O&M costs are summarizes in Appendix D.

8.3 RECURRING PERIODIC COST ITEMS SUMMARY

Estimated recurring periodic costs are summarized in Table 8-3.

Table 8-3. Recurring Periodic Cost Items ($1000)

Item	Petersburg 1	Petersburg 2	Petersburg 3	Petersburg 4	Harding Street 7
ESP enhancements	$3,600		$1,700	$5,400	
Filter bag replacement		$1,947	$1,839		
Wet FGD demister packing	$300	$300	$300	$300	$300

ESP enhancements will be implemented before the MATS compliance deadline. It is expected that more ESP enhancements will be required in the future because of the more stringent MATS FPM limitations. Recurring costs are included to perform significant work activities after 7 years and after 14 years.

Filter bags will have to be replaced after four years of operation. This cost is included in the annual total. The cages used to support the bags need replacement every eight years.

To minimize FPM emissions, the MEs (demisters) must be in good condition to prevent generation of FPM. The frequency of ME (demister) replacement will increase to every year instead from every two years.

8.4 NET PRESENT VALUE REVENUE REQUIRMENTS

Options were compared on the basis of net present value of revenue requirements (NPVRR), a procedure commonly used in the electric power industry for planning and capital budgeting. The revenue requirement for a given alternative is total revenue that must be collected from customers to cover all costs associated with the alternative, including operating expenses and carrying charges on invested capital. Carrying charges on capital consist of return on debt, return on equity, federal and state income taxes associated with return on equity, book depreciation, property taxes, and insurance.

Table 8-4 lists the assumptions used in the NPVRR analysis.

Table 8-4. NPVRR Assumptions

Parameter	Value
Discount rate	7.42%
Escalation rate	3%
Evaluation period	20 years
First year of operation	2016
NPVRR factor for capital	1.3
NPVRR factor for first-year annual costs	12.861

The 7.42% value used for discounting is representative of the after-tax cost of capital for an investor-owned utility and was provided by IPL. The escalation rate of 3% is a judgment as to what the rate of inflation is likely to be over the 20-year period assumed for this study. The 20-year time horizon has been chosen as a minimum expected remaining operating life for the plant. The project is projected to go into service in 2016, and costs estimated in today's dollars are escalated to times incurred for the NPVRR analysis.

The NPVRR factor for capital, estimated to be 1.3 for this study, is based on typical investor-owned utility financial characteristics. The NPVRR for capital spending is about 30% higher than the spending itself because as costs are recovered over the assumed remaining useful life of the facility, additional funds must be collected from customers to cover income tax (federal and state) for the return-on-equity portion of carrying charges, and to cover property taxes and insurance. This factor also takes into account the tax benefit of accelerated depreciation, as allowed under the Modified Accelerated Cost Recovery System (MACRS) depreciation system applicable under U.S. tax law.

The NPVRR factor of 12.861 converts a first-year cost into an NPVRR value, taking into account escalation and discounting over the evaluation period. This same NPVRR factor is used to convert an annual fuel cost differential into an NPV. Table 8-5 illustrates the calculation of the 12.861 NPVRR value.

Table 8-5. Calculation of NPVRR Factor for Annual Costs

Year	Escalation Factors	NPVRR Factors	NPVRR Escalated Cost
1	1.0000	0.9309	0.931
2	1.0300	0.8666	0.893
3	1.0609	0.8068	0.856
4	1.0927	0.7510	0.821
5	1.1255	0.6992	0.787
6	1.1593	0.6509	0.755
7	1.1941	0.6059	0.723
8	1.2299	0.5641	0.694
9	1.2668	0.5251	0.665
10	1.3048	0.4888	0.638
11	1.3439	0.4551	0.612
12	1.3842	0.4236	0.586
13	1.4258	0.3944	0.562
14	1.4685	0.3671	0.539
15	1.5126	0.3418	0.517
16	1.5580	0.3182	0.496
17	1.6047	0.2962	0.475
18	1.6528	0.2757	0.456
19	1.7024	0.2567	0.437
20	1.7535	0.2389	0.419
			12.861

Table 8-6 summarizes the NPVRR costs for ESP and baghouse options, respectively. The NPVRR includes capital and annual costs, but does not include differential fuel costs.

Table 8-6. NPVRR Total Cost Summary ($Millions)

Description	Petersburg 1	Petersburg 2	Petersburg 3	Petersburg 4	Harding Street 7
SI + ACI + Existing ESP + Wet FGD	$131	$298	$258	$279	$157
SI + ACI + Baghouse + Wet FGD	$233	$323	$321	$369	$317

9. EVALUATION OF COMPLIANCE OPTIONS

9.1 BACKGROUND

An Hg emission reduction plan can use technology to capture Hg or can use coal switching to lower the Hg in the coal, or a combination of these. The selection of an economical emissions control plan requires consideration of the retrofit control technology costs along with the fuel cost and any associated risks.

The capital and O&M costs for the control technology are discussed in Section 8 of the report, and detailed in Appendix D. The fuel cost is a differential representing an increase or decrease from current coal costs. The total NPVRR includes the capital, the O&M, and the differential fuel cost for a 20-year evaluation, and is used to compare options on the same economic basis.

The Petersburg analysis evaluates all of the control scenarios that can be used and includes the cost at three coal Hg levels. The scenarios shown comply with MATS emission limits for HCl, FPM, and Hg. The scenarios include installing 0, 1, 2, or 3 baghouses at each fuel level. The Harding Street analysis is similar, but compares the cost of upgrading the ESP and installation of a baghouse.

9.2 PETERSBURG STATION RESULTS

9.2.1 Fuel Factors with Hg Emission Compliance

All Hg values discussed in this report are based upon historical data collected by IPL quarterly fuel samples over the past five years for the Indiana coals that are currently under contract. Further research of Indiana Geological Society and USGS data indicate that Indiana coals are some of the lowest Hg coals in the U.S. There are three small pockets of coal in Wyoming, Utah, and Colorado that also have coals with Hg content under 5 lbs/TBtu category. Also, some Illinois Basin coal in Kentucky and Illinois is similar to Indiana coals with respect to Hg content, though not lower. Thus, IPL does not have the opportunity of switching to another source of low-Hg coal in order to comply with the new rules.

In addition, there is little data available on the Hg content of coal that is likely to be mined in the future. Because of this, we presume the future coal will be similar to what has been burned in the past.

For purposes of the Petersburg study, the coals are categorized as follows:

- "Highly Constrained Low-Hg Coals" with a weighted quarterly maximum ≤8 lbs/TBtu when several are fired at the station. The price could increase based on transportation costs and an increased demand for the low-Hg coal. To bring these coals to Petersburg Station would add [redacted]Ton above the current cost of coal. This value includes an increase in transportation cost of [redacted]on and [redacted]Ton for a market price adder. The market price adder accounts for the additional demand for low-Hg in the industry and the limited supply of this coal. A similar price increase occurs when a utility purchases low-sulfur coal; the mine is able to add a premium because the low-sulfur coal represents more value to utilities.
- "Constrained Medium Hg Coals" with a weighted quarterly maximum ≤9 lbs/TBtu. To bring in similar Hg coals to Petersburg would add [redacted]Ton above the current cost of coal. This value includes an increase in transportation cost of [redacted]ton and in increase due to a market price of [redacted]Ton.
- "Local Unconstrained Coals" with a weighted quarterly maximum ≤11.2 lbs/TBtu. These coals are the closest to Petersburg and have the lowest transportation costs, and are the coals currently fired at Petersburg. No cost differential to add for these coals.

The station will fire coals from several mines simultaneously so selecting one coal and using its characteristics would not accurately reflect the Hg emissions expected. The weighted Hg content based on averaging the maximum values from the quarterly fuel samples is used to approximate the coal Hg content that could arrive from several mines and be fired at a station during a 90-day period.

Options that utilize a high local unconstrained coal (<11.2 lbs/TBtu) have the following features with regard to coal:

- These options would allow Petersburg to continue to rely on the same mines that currently supply the station, including those that are closer to the station and have lower coal transportation costs. This option includes the mines with the higher Hg coal contents, such as found in southern Indiana mines.
- These options represent a less complex coal supply scenario because delivery can be by truck or rail and sourcing is not constrained. If coal comes from farther north, it will likely involve interchanging with other railroads, which will add cost and delivery time. Increased train cycle times are important because they may restrict the amount of coal received by rail, which could increase the amount of coal received by truck and greatly increase transportation costs.
- Highly constrained low-Hg mines are expected to add a premium to their prices because of the greater value of this characteristic. Increased demand for lower Hg coals is unknown because the control plans of other utilities are not known at this time. Thus, the premium these mines will be able to command is also unknown. No premium is added to the higher Hg coals because of the higher Hg content. Overall, the coal price for the higher Hg mines has less risk because no increase in demand for these coals is expected.

- Coal supply is adequate in that these mines have enough capacity for Petersburg Station. An unconstrained supply can last for the 20-year evaluation period.

Options that utilize a constrained medium-Hg coal (<9 lbs/TBtu) have the following features with regard to coal:

- These options rely on mines that are further away from the Petersburg Station. These mines would deliver coal using one to three railroads. This adds complexity to the logistics of coal delivery and would increase train cycle times. It also adds risk that some of the coal would have to be delivered by truck at significantly higher transport cost.
- There is some risk of price escalation because the medium-Hg lb/TBtu coal will be in more demand than the higher-Hg coal, but in less demand than the low-Hg coal. The amount of price increase is unknown but is expected to be on the order of at least several dollars per ton.
- Based on the evaluation, the coal supply may not be adequate in that these mines may not have sufficient capacity for the Petersburg Station. (See related discussion below under the low-Hg coal (8 lbs/TBtu.)
- Potential risk for these options that have the higher coal cost differential is the effect that increased variable costs (i.e., fuel) would have on the dispatchability if the Petersburg units within the MISO region.

Options that utilize a low-Hg coal (<8 lbs/TBtu) have the following features with regard to coal:

- These options have significant coal price risk because this low-Hg coal could be in greater demand based on the control plans of other utilities and the price differential could be greater than anticipated.
- These options have significant coal supply risk since there are a limited number of active mines that could be used [redacted]
- One fatal flaw could be insufficient coal available to feed 5.5 million TPY to Petersburg and 1.7 million TPY to Harding Street Unit 7. Moreover, the supply could also be depleted by other users, e.g., Hoosier Energy and Duke. Additionally, because Hoosier Energy's Merom Station is only [redacted] and Duke has a one-line haul on CSX direct to its Gibson and Cayuga stations, it is clear that both entities enjoy a considerable transportation advantage over IPL from these three mines.
- The complexity of shipping this coal to Petersburg poses risk if coal supply issues arise, even if temporary. In such cases, units would have to be derated or shut down until supply is restored, assuming it can be.
- The same issue exists regarding dispatchability of the Petersburg units due to higher busbar costs, which is even more of a concern with even higher transport costs.

In summary, the high-Hg coal presents less risk of coal cost increases as more utilities seek lower Hg coals. The cost differential used is a realistic value to expect in switching from high-Hg coal to lower Hg coal.

9.2.2 NPVRR Evaluation of Control Technology Options

The options recommended for final consideration had to be highly reliable and cost-effective with regard to compliance with the MATS Rule. With regard to emission compliance, the high reliability aspect was evaluated based on two criteria: (1) the options had to provide compliance when the expected maximum Hg for a coal mix was fired at full load with the control technology operating as designed, and (2) the options had to provide compliance when the average Hg for a coal mix is fired and the largest, lowest-emitting unit was in outage. Appendix B contains two spreadsheets illustrative of these criteria. The first spreadsheet applies to criteria 1 with maximum Hg in the coal and the second spreadsheet applies to criteria 2. Cost effectiveness was evaluated based on NPVRR.

The NPVRR evaluation for Petersburg considers the control technologies deemed feasible for each unit at Petersburg as discussed in Section 5 of this report. The NPVRR includes the capital and annual costs of the new technologies as discussed in Section 8. The NPVRR evaluation also considers the three coal types discussed previously.

To reduce the number of iterations in the NPVRR analysis, baghouse technology options for Unit 1 were not included in the NPVRR analysis. This unit is significantly smaller than and has a lower capacity factor than the other three units. Further, this unit has a small impact on the total emissions from the station when averaged. It was determined that it would be more prudent to consider a baghouse on the other three units and not on Unit 1.

The cost of compliance for several technology options at three different coal Hg levels is shown in Appendix E for Petersburg Station. In the appendix, the three coal Hg contents are headlined with the yellow banner. The Hg emissions are shown on individual units, station average, and with one unit in outage. Options with blue highlight include a baghouse over the emissions values. For options not achieving compliance requirements, the economic rows are shown in red. One option did not meet MATS limits with one unit in outage and this option shows that emission in red.

In Appendix E, the NPVRR is shown for each option in the rows with a green headline. The total NPVRR is evaluated on a 20-year period using the economic factors identified in Section 8. The NPVRR for capital and annual costs are listed as well as the NPVRR for fuel-related costs. A fuel cost differential is added for the options that will utilize a coal mix that is significantly different from the current coals fired at the station. Three categories initially were considered: those representing a 90-day maximum of 11.2 lbs/TBtu, 9 lbs/TBtu, and 8 lbs/TBtu.

The six lowest-cost options from Appendix E are presented in Table 9-1.

Table 9-1. Acceptable Technologies to Achieve MATS Emission Compliance at Petersburg

Option	Maximum and Average Coal Hg Content (lb/TBtu)	Units with Baghouses	NPVRR ($Million)	NPVRR Difference (%)	Hg Emission with Max Hg Coal & No Units in Outage and (lb/TBtu)	Hg Emission with Ave Hg Coal & One Units in Outage and (lb/TBtu)	FPM Emission (lb/MMBtu)	HCl Emission (lb/MMBtu)
1	11.2/9.0	P2 & P3	1054	Base	0.87	0.81	0.017	<0.002
2	11.2/9.0	P2 &P4	1081	3%	0.90	0.86	0.018	<0.002
3	11.2/9.0	P3 & P4	1119	6%	0.76	0.69	0.017	<0.002
4	11.2/9.0	P2, P3, & P4	1144	9%	0.66	0.56	0.014	<0.002
5	9.0/6.5	P2	1259	19%	0.90	0.71	0.019	<0.002
6	8.0/5.5	None	1364	29%	0.87	0.6	0.021	<0.002

Table 9-1 shows that the lowest NPV, Option 1, with baghouses on Units 2 and 3 and existing ESPs on Units 1 and 4 and firing the current 11.2 lbs/TBtu fuel. This option can be implemented within the dates listed in MATS regulation based on being granted the one-year extension. Because the station already fires these coals, this option presents little risk related to the station's ability to fire the coal, deliver that coal at a low price, or longevity of the coal mines. This option is projected to comply with MATS for all pollutants and includes some operating margin on each pollutant. With the lowest emission rate unit out for a 90-day period, the station is at the compliance emission limit, but emissions can be lowered with lower-Hg coal, or possibly achieving more Hg removal than predicted out of the baghouse technology. The units with proposed baghouses, Petersburg Units 2 and 3, have little risk of meeting the 95% Hg removal efficiency and FPM emission limit of 0.03 lb/MMBtu because baghouse ahead of FGD systems have demonstrated these or lower values at several installations. Although it was not tested, there is little risk in the projections of Hg removal on Unit 1 because its conditions are similar to Harding Street Unit 7 and the Harding Street test results are very applicable to Unit 1. The Unit 4 proposed Hg controls include some risk because the predicted removal efficiency is based on Unit 2 test data and Unit 4 has a slightly shorter residence time for SI and ACI injection. In S&L's judgment, the removal efficiency is achievable, and the testing at Harding Street Unit 7, where there was short residence time, would support that conclusion.

The second-lowest option is similar to the first in that it has two baghouses, but they are on Units 2 and 4. The option would fire the 11.2 lbs/TBtu coal. The discussion for the first option applies to this option. The option had one risk in that it could not comply if a unit was out of service and 11.2 lbs/Hg coal was received the entire 90-day averaging period. This is a low-probability event. Otherwise, this option has the same risk profile as Option 1.

Since these two options have NPVs that are nearly identical, they will be compared more closely at the end of the section.

The third-ranked option is similar to the first and second options in that it also has two baghouses; however, the option is 6% higher NPV. One advantage is that this option has slightly lower Hg emissions than the low-cost options and it meets the emission target with one baghouse unit in outage. In S&L's judgment, this higher cost is not practical compared to the first two options.

The fourth-ranked option is 9% higher NPVRR compared to the base option. Because this option has three baghouses, it has greater capital cost, but it uses the local unconstrained high-Hg coal and, therefore, there is no fuel cost differential. This option has an Hg and FPM emission advantage because the three baghouses lower the emissions well below the MATS emission limits. However, the low-cost options do comply with MATS and, therefore, there is no need for additional expenditures to achieve lower emissions. S&L does not recommend this option because of its greater cost.

The fifth-ranked option is 19% higher NPVRR then the base option. This option includes only one baghouse, which is a savings in capital, but there is a coal cost differential added to this option. The cost of bringing the constrained medium-Hg coal to the station is greater than the cost of a second baghouse. This option has no Hg or FPM emission advantage compared to the higher-ranked options and is more expensive. S&L does not recommend this option because it is greater cost and has no advantages over other options.

The sixth-ranked option is the highest NPVRR cost at 29%. The differential fuel cost is significant and makes this option the most expensive. The fuel cost relates to bringing the highly constrained low-Hg coal to Petersburg Station. The differential includes the added transportation cost and the cost due to the market demand for this valuable low-Hg coal. This option takes on the added risks if Petersburg relies on this coal for its operations for the next 20 years and if this highly constrained low-Hg coal escalates in price more than expected. In addition, this highly constrained coal is the same coal that Harding Street purchases and could result in Petersburg competing with Harding Street for the same coal. Note that this option at 8 lbs/TBtu Hg is between the highly constrained low-Hg coal and constrained medium-Hg coal categories.

Additionally, the sixth option has lower Hg emissions compared to the other options, but all the others do meet the environmental target of 0.90 lb/TBtu Hg emissions on a station average. This option does have a weakness in that it relies on all of the existing ESPs. The existing ESPs cannot control FPM to as low of a value as can the other options because a baghouse is not included. This option has the highest FPM emissions.

S&L does not recommend the sixth-ranked option because other options offer lower costs and lower risk of non-compliance with MATS, in addition to lower risk of coal price escalation.

To summarize, returning to the first- and second-ranked options, the lowest option has several advantages with baghouses on Units 2 and 3 as follows:

- The first-ranked option has the lower NPVRR and has baghouses on Units 2 and 3.
- Unit 4 baghouse is more expensive because there is insufficient space near the boiler to build the baghouse. It is located along the river in the flood plain and special permits will be needed to build in this area.
- As Unit 4 does not have a major outage before the MATS compliance date, IPL would be required to take an unscheduled outage to tie in the baghouse. This lost revenue and purchase power were not included in the cost estimate.
- Unit 4 does not currently have an SCR, unlike Unit 3. In dispatching the units, having the baghouse on Unit 3 would give it a full complement of AQCS equipment and would allow it to be dispatched at a higher capacity factor without concern for exceeding non-MATS requirements.
- Installing the baghouse on Unit 3 helps keep the area around Unit 4 clear for an SCR retrofit if needed in the future.

These features support the first-ranked option that would install a baghouse on Units 2 and 3 and reuse of the ESPs on Units 1 and 4. S&L recommends that IPL implement the low-NPVRR option at Petersburg.

9.3 SELECTED OPTION FOR PETERSBURG

The recommended option is to install baghouses on Petersburg Units 2 and 3. This is the low-cost option in this analysis. Also, this is recommended in order to maintain the flexibility to remain unconstrained with regard to fuel purchases. It relies on existing ESPs on Units 1, 3, and 4, and these ESPs will need to be enhanced to maximize their reliability and their performance. This option also requires FGD upgrades on Units 1 and 2 to enhance FGD reliability and minimize the occurrences of FGD bypasses.

The recommended environmental control plan is the best of several options for Petersburg because the plan: (1) provides reliable compliance with MATS emissions limits for Hg, non-Hg metal HAPs, and acid gas HAPs; (2) allows reliable generation of electricity because it uses a reliable fuel supply, uses coals that are currently fired at the station and familiar to the station staff, does not rely on lower-Hg coals that are less available, relies on retrofit control equipment that will be designed with redundancy for reliable service; and (3) is cost-effective with a low NPVRR even though it includes higher capital costs than some options, yet does not require an increase in coal costs due to a need to purchase lower-Hg coal.

9.4 SELECTED OPTION FOR HARDING STREET STATION RESULTS

The Harding Street Station can comply without a baghouse, but will need upgraded performance from the ESP to comply with MATS FPM emission limits. The cost of a baghouse is significantly greater, as shown in Appendix F. IPL is contracted for sufficient low-Hg coal for approximately 10 years. The design coal was selected at 9 lbs/TBtu for this unit based on coal sourcing. After 10 years, the coal market and control technology market can be re-evaluated and a determination made as to whether a new approach is needed at Harding Street Unit 7. This option also requires FGD upgrades to enhance reliability and minimize the occurrences of FGD bypasses.

S&L recommends that IPL upgrade the ESP at Harding Street Unit 7 and maintain the current fuel supply.

10. RECOMMENDED ENVIRONMENTAL CONTROL PLAN

10.1 PETERSBURG ENVIRONMENTAL CONTROL PLAN

The recommended control plan for Petersburg is as follows:

- The entire station can fire a coal with a maximum 90-day average Hg of ≤11.2 lbs/TBtu.
- Petersburg Unit 1 needs SI (Trona) followed by ACI (brominated PAC) followed by the existing ESP and FGD. To enhance reliability and performance, ESP enhancements and FGD upgrades are included.
- Petersburg Unit 2 needs SI (hydrated lime) injected ahead of the air heater followed by ACI (brominated PAC) followed by a new baghouse that replaces the existing ESP and FGD. To enhance reliability, FGD upgrades are included.
- Petersburg Unit 3 will reuse the existing ESP to collect fly ash for sale, the ESP needs enhancements to improve reliability, then SI (hydrated lime) will be injected ahead of the air heater and followed by ACI, which will be injected ahead of the new baghouse. The ESP collected fly ash will not be contaminated with PAC.
- Petersburg Unit 4 needs SI (Trona) followed by ACI ahead of the air heater followed by the existing ESP to enhance reliability and performance, the ESP needs enhancement.

10.2 HARDING STREET UNIT 7 ENVIRONMENTAL CONTROL PLAN

The recommended control plan for Harding Street is as follows:

- Unit 7 is able to fire the current mix of coals. These coals typically have a maximum 30-day average of <9 lbs/TBtu Hg.
- Install ACI at Harding Street Unit 7 followed by implementing upgrades to the ESP and to the FGD system to increase reliability.
- SI System upgrades to increase reliability of SBS System.

10.3 COST CONCLUSIONS

The capital, annual, and NPVRR costs for the recommended environmental control plan are presented in detail in Appendix D and summarized below in Table 10-1.

Table 10-1. Summary of Recommended Control Plan Costs

Cost Description	Pete Unit 1 -w- Existing ESP	Pete Unit 2 -w- New Baghouse	Pete Unit 3 -w- ESP & Polishing Baghouse	Pete Unit 4 -w- Existing ESP	HSS Unit 7 -w- Existing ESP
Capital (Equipment, Material & Labor)					
New Assets					
BH	NA	28,614,000	29,779,000	NA	NA
ESP Upgrades	950,000	NA	NA	1,750,000	24,500,000
Ductwork	NA	13,649,000	18,280,000	NA	5,300,000
Steel (Excluding Ductwork)	2,000,000	13,801,000	10,730,000	2,000,000	2,600,000
Fans	-	4,891,000	5,029,000	-	-
SI	3,070,000	3,315,000	3,360,000	3,890,000	400,000
ACI	1,230,000	1,182,000	1,357,000	1,620,000	1,200,000
CEMS (1.5 M per Stack system incl. Hg, HCL, FPM)	4,900,000	4,900,000	2,450,000	2,450,000	4,700,000
Electrical Equipment	600,000	5,249,000	6,869,000	600,000	600,000
BOP (Electrical, Air, Demo, Etc.)	4,823,000	28,970,000	21,030,000	3,660,000	4,000,000
BOP (Demo)	400,000	3,590,000	2,199,000	450,000	1,200,000
WFGD Upgrades	2,700,000	2,700,000	NA	NA	500,000
Relocation of Unit 3 BH to Flood Plain	-	-	NA	NA	NA
Other Direct and Const Indirect	4,842,000	29,738,000	27,639,000	3,846,000	10,539,000
Indirect Cost	3,876,100	15,466,000	14,159,000	3,613,100	6,109,000
Total Escalation	1,704,000	7,405,000	8,322,000	1,384,000	3,573,000
Total Contingency	6,064,000	20,661,000	19,436,000	4,899,000	12,330,000
Subtotal New Assets	37,159,100	184,131,000	170,639,000	30,162,100	77,551,000
Enhancements of Existing Assets					
ESP Enhancements	3,600,000		1,695,000	5,400,000	
Reduce Air Inleakage from Ducts	1,575,000	2,048,000	1,337,000	1,400,000	2,800,000
Reduce Air Inleakage from Fans	438,000	-	-	438,000	0
Subtotal Enhansements of Existing Assets	5,613,000	2,048,000	3,032,000	7,238,000	2,800,000
Total Project Costs	42,800,000	186,200,000	173,700,000	37,400,000	80,400,000
NPVRR Total Capital & Improved Assets	55,640,000	242,060,000	225,810,000	48,620,000	104,520,000
Other Costs					
Testing	325,000	325,000	325,000	325,000	325,000
Power Sales Lost Due to Outage	-	-	-		-
Variable O&M ($/yr)					
ACI					
ton/year	1,423	1,608	2,151	5,385	1,171
ton/year @ 82% Capacity Factor	1,167	1,319	1,764	4,416	960
ACI $ at $1790/ton	2,088,770	2,360,716	3,156,878	7,903,768	1,718,848
ACI Increased Ash Loading Disposal					
$	Insignificant	Base	Base	Insignificant	Insignificant
DSI					
ton/year - Trona	8,760	na	na	21,900	-
ton/year - Trona @ 82% Capacity Factor	6,920	na	na	17,301	-
DSI $ at $175/ton	1,211,070			3,027,675	-
ton/year - Hydrate Lime	na	6,570	7,884	na	na
ton/year - Hydrate Lime @ 82% Capacity Factor	na	5,387	6,465	na	na
DSI $ at $150/ton		808,110	969,732		
Fly Ash					
ton/year	-	na	na	145,514	-
$ @ IPL estimated disposal cost	-	na	na	2,776,000	-
Gypsum					
ton/year	-	na	na	-	-
$ @ 20/ton disposal cost	-	na	na	-	-
Auxiliary Power					
MWh	10,383	26,971	35,408	26,193	21,361
Auv Power $ at $35/MWh	363,417	943,976	1,239,292	916,763	747,638
Bags					
$	na	486,720	459,680	na	na
Misc. Operating Repairs	Base	Base	Base	Base	Base
WFGD Dismister Packing Replaced More Frequently	150,000	150,000	150,000	150,000	150,000
Years of Escalation	4	4	4	4	4
Fixed O&M ($/yr)					
WFGD (Increased Ash Loading) $	150,000	na	na	150,000	150,000
$					
Operations & Maintanence Labor - New Equipment					
CEMS	800,000	800,000	400,000	400,000	650,000
ACI/DSI	45,000	45,000	45,000	45,000	45,000
Ductwork $	150,000	na	na	150,000	150,000
$ Total Annual O&M (first year cost)	4,958,257	5,594,522	6,420,582	15,519,206	3,611,486
$ Total Annual O&M with escalation (2016$)	5,580,562	6,296,684	7,226,422	17,467,003	4,064,759
$ NPVRR Annual Total O&M	71,769,517	80,979,292	92,936,309	224,636,588	52,275,347
NPVRR Future ESP Enhancements in Year 7, 14	3,489,077	-	1,356,238	5,289,891	-
$ NPVRR Total Capital, Other and O&M	$131,000,000	$323,000,000	$321,000,000	$279,000,000	$157,000,000

11. CONTROL PLAN OPTION SCHEDULE

The environmental control plan schedules for Petersburg Station Units 1-4 and Harding Street Unit 7 are provided in Appendix G. Based on the milestones in these schedules and one-year extension from the state of Indiana, compliance with MATS for all five units will be achieved by April 16, 2016.

The schedules integrate the engineering, equipment procurement, delivery, and construction, with the existing planned outages for each of the units. The plan is based on the Unit 3 baghouse being installed at the location currently occupied by the Unit 2 ESP. Once the Unit 2 baghouse is operational, the Unit 2 ESP can be demolished, and the Unit 3 baghouse installed in the existing location of the Unit 2 ESP.

The differences between the original and final MATS Regulation led IPL to conduct additional planning, testing, and conceptual design work to identify the least-cost MATS environmental control plan. This work delayed the implementation of the final control plan and prevented the Unit 2 baghouse from being installed in the Unit 2 2013 major maintenance outage. Based on this delay and the need to demolish the Unit 2 ESP prior to installing the Unit 3 baghouse, a spring 2016 start up of the Unit 3 baghouse is required.

APPENDIX A.
PROJECTED FPM EMISSIONS FOR THE BIG FIVE UNITS

Predicted Total FPM Emissions for Big Five Based on Various Coal Strategies

	With Enhanced ESPs [1]					With Enhanced ESPs and Baghouse at Petersburg Unit 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Key Characteristic:										
ESP Size (SCA, sq. ft./1000 acfm)	161	440	164	330	110	215	N/A	N/A	330	110
Aspect Ratio (Length/Height)	0.9	1.3	1.2	1	1	0.9	N/A	N/A	1	1
Teatment Time (seconds)	4.5	13	5.1	9.6	3.2	4.5	N/A	N/A	9.6	3.2
Velocity through ESP (fps)	6.1	4.6	7.1	5	8 to 9	6.1	N/A	N/A	5	8 to 9
Complications from DSI	No	No	No	No	Yes	No	N/A	N/A	No	Yes
Wet FGD Present	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Performance With Maximum Ash Coal:	With Enhanced ESPs					With Enhanced ESPs and Baghouse at Petersburg Unit 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HSS 7	Pete 1	Pete 2	Pete 3	Pete 4	HSS 7
Tested or Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted
Flue Gas Flow (MMACFM)	1.08	2.04	2.73	2.73	2.23	1.08	2.04	2.73	2.73	2.23
Coal Ash (% dry basis)	9.5	9.5	9.5	9.5	10.5	9.5	9.5	9.5	9.5	10.5
Fly Ash Loading Rate:										
(lb/MBtu)	6.4	6.4	6.4	6.4	7.0	6.4	6.4	6.4	6.4	7.0
(lb/hr)	14080	26522	35456	35520	29008	14080	26522	35456	35520	29008
LOI										
(lb/MBtu)	0.3	0.26	0.03	0.03	0.33	0.3	0.26	0.03	0.03	0.33
(lb/hr)	660	1077	166	167	1368	660	1077	166	167	1367.52
Trona Solids Rate						0	0	0	0	0
(lb/MBtu)	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
(lb/hr)	1606	3025	4044	4052	3025	1606	3025	4044	4052	3025
PAC Br Feed Rate:						0	0	0	0	0
(lb/MBtu)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
(lb/hr)	484	912	1219	1221	912	484	912	1219	1221	912
Solids Loading to ESP (lb/MBtu)	7.7	7.2	7.5	7.5	7.8	7.7	7.2	7.5	7.5	7.8
ESP Removal Efficiency (%)	99.27%	99.50%	99.37%	99.52%	99.14%	99.27%	99.90%	99.90%	99.52%	99.14%
ESP Outlet Emission Rate (lb/MBtu)	0.056	0.036	0.047	0.036	0.067	0.056	0.007	0.007	0.036	0.067
FGD Removal Efficiency (%)	58%	46%	52%	46%	63%	58%	-80%	-80%	46%	63%
Stack Emission Rate (lb/MBtu)	0.024	0.019	0.023	0.019	0.025	0.024	0.013	0.013	0.019	0.025
Weighted Contribution to Station total (lb/MBtu)	0.003	0.005	0.007	0.006	N/A	0.003	0.003	0.004	0.006	N/A
Station Average Hg Emission rate with all Units Operating (lb/MBtu)	0.021				N/A	0.017				N/A
Station Hg Total Emission Rate Goal (lb/MBtu)	**0.025 on 30-day average**				**0.025 on 30-day average**	**0.025 on 30-day average**				**0.025 on 30-day average**
Weighted Contribution to Station total (lb/MBtu)	0.004	0.007	0.011	0.000	N/A	0.004	0.005	0.000	0.009	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/MBtu)	0.022				N/A	0.018				N/A

Performance With Maximum Ash Coal:	With "Upgraded" ESPs [2]					With "Upgraded" ESPs and Baghouse at Petersburg Unit 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Tested or Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted	Predicted
Flue Gas Flow										
(Million afcm)	1.083	2.04	2.73	2.73	2.23					
						0	0	0	0	0
Fly Ash Loading Rate:						0	0	0	0	0
(lb/MBtu)	6.4	6.4	6.4	6.4	7.0	6.4	6.4	6.4	6.4	7.0
(lb/hr)	14080	26522	35456	35456	29008	14080	26522	35456	35456	29008
LOI										
(lb/MBtu)	0.3	0.26	0.03	0.03	0.33	0.3	0.26	0.03	0.03	0.33
(lb/hr)	660	1077	166	166	1368	660	1077	166	166	1368
Trona Solids Rate						0	0	0	0	0
(lb/MBtu)	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
(lb/hr)	1606	3025	4044	4044	3025	1606	3025	4044	4044	3025
PAC Br Feed Rate:						0	0	0	0	0
(lb/MBtu)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
(lb/hr)	484	912	1219	1219	912	484	912	1219	1219	912
Solids Loading to ESP (lb/MBtu)	7.7	7.2	7.5	7.5	7.8	7.7	7.2	7.5	7.5	7.8
ESP Removal Efficiency (%)	99.70%	99.80%	99.70%	99.80%	99.60%	99.70%	99.90%	99.90%	99.80%	99.60%
ESP Outlet Emission Rate (lb/MBtu)	0.023	0.014	0.022	0.015	0.031	0.023	0.007	0.007	0.015	0.031
FGD Removal Efficiency (%)	35%	0%	35%	0%	40%	35%	-80%	-80%	0%	40%
Stack Emission Rate (lb/MBtu)	0.015	0.014	0.015	0.015	0.019	0.015	0.013	0.013	0.015	0.019
Weighted Contribution to Station total (lb/MBtu)	0.002	0.003	0.005	0.005	N/A	0.002	0.003	0.004	0.005	N/A
Station Average Hg Emission rate with all Units Operating (lb/MBtu)	0.015				N/A	0.014				N/A
Station Hg Total Emission Rate Goal (lb/MBtu)	**0.025 on 30-day average**				**0.025 on 30-day average**	**0.025 on 30-day average**				**0.025 on 30-day average**
Weighted Contribution to Station total (lb/MBtu)	0.003	0.005	0.007	0.000	N/A	0.003	0.005	0.000	0.007	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/MBtu)	0.015				N/A	0.014				N/A

Note 1. Enhanced ESP is an ESP that uses most of the existing internals and
Note 2. Upgaded ESP is one that has the entire internals replaced with state-of-the-art internals (electrodes, insulators, suppots, etc.)

APPENDIX B.
PREDICTED TOTAL HG EMISSIONS FOR THE BIG FIVE UNITS BASED ON COALS WITH VARIOUS HG CONTENTS

Predicted Total Hg Emissions for Big Five Based on Coals with Various Hg Contents
(Maximum Hg Content of Coal and No Unit in Outage)

Performance Based on 8 lb/TBtu Hg Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.64	0.88	0.96	0.88	0.40	0.64	0.56	0.96	0.88	0.40	0.64	0.56	0.40	0.88	0.40
Weighted Contribution to Station total (lb/Tbtu)	0.08	0.21	0.31	0.28	N/A	0.08	0.13	0.31	0.28	N/A	0.08	0.13	0.13	0.28	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	0.87				N/A	0.80				N/A	0.62				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.64	0.56	0.96	0.40	0.40	0.64	0.88	0.40	0.40	0.40	0.64	0.56	0.40	0.40	0.40
Weighted Contribution to Station total (lb/Tbtu)	0.08	0.13	0.31	0.13	N/A	0.08	0.21	0.13	0.13	N/A	0.08	0.13	0.13	0.13	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	0.65				N/A	0.54				N/A	0.47				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

Performance Based on 9 lb/TBtu Hg Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.72	0.99	1.08	0.99	0.45	0.72	0.63	1.08	0.99	0.45	0.72	0.63	0.45	0.99	0.45
Weighted Contribution to Station total (lb/Tbtu)	0.09	0.24	0.34	0.32	N/A	0.09	0.15	0.34	0.32	N/A	0.09	0.15	0.14	0.32	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	0.98				N/A	0.90				N/A	0.70				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.72	0.63	1.08	0.45	0.45	0.72	0.99	0.45	0.45	0.45	0.72	0.63	0.45	0.45	0.45
Weighted Contribution to Station total (lb/Tbtu)	0.09	0.15	0.34	0.14	N/A	0.09	0.24	0.14	0.14	N/A	0.09	0.15	0.14	0.14	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	0.73				N/A	0.61				N/A	0.53				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

Performance Based on 10 lb/TBtu Hg Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.80	1.10	1.20	1.10	0.50	0.80	0.70	1.20	1.10	0.50	0.80	0.70	0.50	1.10	0.50
Weighted Contribution to Station total (lb/Tbtu)	0.10	0.26	0.38	0.35	N/A	0.10	0.17	0.38	0.35	N/A	0.10	0.17	0.16	0.35	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	1.09				N/A	1.00				N/A	0.78				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.80	0.70	1.20	0.50	0.50	0.80	1.10	0.50	0.50	0.50	0.80	0.70	0.50	0.50	0.50
Weighted Contribution to Station total (lb/Tbtu)	0.10	0.17	0.38	0.16	N/A	0.10	0.26	0.16	0.16	N/A	0.10	0.17	0.16	0.16	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	0.81				N/A	0.68				N/A	0.59				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

Performance Based on 11.2 lb/TBtu Hg Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.90	1.23	1.34	1.23	0.56	0.90	0.78	1.34	1.23	0.56	0.90	0.78	0.56	1.23	0.56
Weighted Contribution to Station total (lb/Tbtu)	0.11	0.29	0.43	0.39	N/A	0.11	0.19	0.43	0.39	N/A	0.11	0.19	0.18	0.39	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	1.22				N/A	1.12				N/A	0.87				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.90	0.78	1.34	0.56	0.56	0.90	1.23	0.56	0.56	0.56	0.90	0.78	0.56	0.56	0.56
Weighted Contribution to Station total (lb/Tbtu)	0.11	0.19	0.43	0.18	N/A	0.11	0.29	0.18	0.18	N/A	0.11	0.19	0.18	0.18	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	0.90				N/A	0.76				N/A	0.66				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

Performance Based on 12 lb/TBtu Hg Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.96	1.32	1.44	1.32	0.60	0.96	0.84	1.44	1.32	0.60	0.96	0.84	0.60	1.32	0.60
Weighted Contribution to Station total (lb/Tbtu)	0.12	0.31	0.46	0.42	N/A	0.12	0.20	0.46	0.42	N/A	0.12	0.20	0.19	0.42	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	1.31				N/A	1.20				N/A	0.93				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.96	0.84	1.44	0.60	0.60	0.96	1.32	0.60	0.60	0.60	0.96	0.84	0.60	0.60	0.60
Weighted Contribution to Station total (lb/Tbtu)	0.12	0.20	0.46	0.19	N/A	0.12	0.31	0.19	0.19	N/A	0.12	0.20	0.19	0.19	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	0.97				N/A	0.82				N/A	0.70				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

Performance Based on 14 lb/TBtu Hg Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	1.12	1.54	1.68	1.54	0.70	1.12	0.98	1.68	1.54	0.70	1.12	0.98	0.70	1.54	0.70
Weighted Contribution to Station total (lb/Tbtu)	0.14	0.37	0.53	0.49	N/A	0.14	0.23	0.53	0.49	N/A	0.14	0.23	0.22	0.49	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	1.53				N/A	1.40				N/A	1.09				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
Total Hg:															
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	1.12	0.98	1.68	0.70	0.70	1.12	1.54	0.70	0.70	0.70	1.12	0.98	0.70	0.70	0.70
Weighted Contribution to Station total (lb/Tbtu)	0.14	0.23	0.53	0.22	N/A	0.14	0.37	0.22	0.22	N/A	0.14	0.23	0.22	0.22	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	1.13				N/A	0.95				N/A	0.82				N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average	0.9 on 90-day average				1.0 on 30-day average

Predicted Total Hg Emissions for Big Five Based on Coals with Various Hg Contents
(Maximum Hg Content of Coal and No Unit in Outage)

Performance Based on an Average of 5.5 lb/TBtu Hg (8 lb/TBtu max) Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.44	0.61	0.66	0.61	0.28	0.44	0.39	0.66	0.61	0.28	0.44	0.39	0.28	0.61	0.28
Weighted Contribution to Station total (lb/Tbtu)	0.08	0.21	0.31	0.00	N/A	0.07	0.00	0.28	0.25	N/A	0.08	0.13	0.00	0.28	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	0.60				N/A	0.60				N/A	0.50				N/A

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.44	0.39	0.66	0.28	0.28	0.44	0.61	0.28	0.28	0.28	0.44	0.39	0.28	0.28	0.28
Weighted Contribution to Station total (lb/Tbtu)	0.08	0.13	0.31	0.00	N/A	0.08	0.21	0.13	0.00	N/A	0.08	0.13	0.13	0.00	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	0.52				N/A	0.42				N/A	0.34				N/A

Performance Based on an average of 6.5 lb/TBtu Hg (9 lb/TBtu max) Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.52	0.72	0.78	0.72	0.33	0.52	0.46	0.78	0.72	0.33	0.52	0.46	0.33	0.72	0.33
Weighted Contribution to Station total (lb/Tbtu)	0.10	0.25	0.36	0.00	N/A	0.09	0.00	0.33	0.30	N/A	0.10	0.16	0.00	0.33	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	0.71				N/A	0.71				N/A	0.59				N/A

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.52	0.46	0.78	0.33	0.33	0.52	0.72	0.33	0.33	0.33	0.52	0.46	0.33	0.33	0.33
Weighted Contribution to Station total (lb/Tbtu)	0.10	0.16	0.36	0.00	N/A	0.10	0.25	0.15	0.00	N/A	0.10	0.16	0.15	0.00	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	0.62				N/A	0.50				N/A	0.41				N/A

Performance Based on an average of 9 lb/TBtu Hg (11.2 lbs/TBtu max) Coal & With Re-Emission of Hg from FGD

	With ESPs					Baghouse at Unit 2					Baghouse at Units 2 and 3				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
ACI + FGD Removal Efficiency (%)	92	89	88	89	95	92	93	88	89	95	92	93	95	89	95
Stack Emission Rate (lb/TBtu)	0.72	0.99	1.08	0.99	0.45	0.72	0.63	1.08	0.99	0.45	0.72	0.63	0.45	0.99	0.45
Weighted Contribution to Station total (lb/Tbtu)	0.13	0.34	0.50	0.00	N/A	0.12	0.00	0.45	0.41	N/A	0.13	0.22	0.00	0.46	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	0.98				N/A	0.98				N/A	0.81				N/A

	Baghouse at Units 2 and 4					Baghouse at Units 3 and 4					Baghouse at Units 2, 3, and 4				
	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7	Pete 1	Pete 2	Pete 3	Pete 4	HS 7
ACI + FGD Removal Efficiency (%)	92	93	88	95	95	92	89	95	95	95	92	93	95	95	95
Stack Emission Rate (lb/TBtu)	0.72	0.63	1.08	0.45	0.45	0.72	0.99	0.45	0.45	0.45	0.72	0.63	0.45	0.45	0.45
Weighted Contribution to Station total (lb/Tbtu)	0.13	0.22	0.50	0.00	N/A	0.13	0.34	0.21	0.00	N/A	0.13	0.22	0.21	0.00	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	0.86				N/A	0.69				N/A	0.56				N/A

APPENDIX C.
2012 DIAGNOSTIC TESTING SUMMARY

Appendix C
IPL Diagnostic Testing Summary

Test Objectives:

To help determine the compliance strategies for the IPL units, testing was performed at Petersburg Unit 2 and Harding Street Unit 7. Testing included three technologies:

- Dry sorbent injection (Trona) at Petersburg
- Brominated powdered activated carbon (PAC) injection at Petersburg and Harding Street
- Halogen-based fuel additives at Petersburg and Harding Street

Dry sorbent addition plays two roles in emission control: First, the removal of SO_3 increases mercury removal, and second, the addition of a sodium-based sorbent has a positive impact on ESP performance, allowing for higher particulate removal. PAC effectively removes mercury by adsorption onto the carbon particle, which is removed by the electrostatic precipitator (ESP). Fuel additives oxidize mercury in the flue gas, to allow for increased removal.

The main test objectives were:

- Demonstrate the ability to comply with MATS with DSI, ACI, and fuel additives,
- Determine the effect of DSI and ACI on FPM levels,
- Determine expected feed rates of DSI and ACI for cost estimation, and
- Determine the impact of Trona, PAC, and fuel additive on byproducts, process streams, and discharge streams.

Background:

Petersburg Unit 2 and Harding Street Unit 7 were selected for extended testing for several reasons, including existing environmental technologies, unit configuration, and unit operational characteristics. Table 1 compares Petersburg Unit 2 and Harding Street Unit 7 environmental controls and operations conditions.

Table 1: Petersburg Unit 2 and Harding Street Unit 7 Characteristics

	Petersburg 2	Harding Street 7
WFGD	Siemens single absorber with liquid distribution rings	Advatech fountain absorber
SCR	Yes	Yes
SCA	~440 @ 12"	~100 @ 12"
Residence Time AHGO to ESP	6 seconds	<2 seconds
ESP Residence Time	11 seconds	6 seconds
AHGO Temperature	360-380°F	~300°F

The differences between these two units allow for extrapolation to other units in the IPL fleet. Testing both styles of absorbers provides more information on the mercury and FPM removal for each design. By testing ESPs with small and large SCAs, the impact of PAC injection on FPM measurements can be analyzed. Along with a larger ESP, Petersburg Unit 2 has longer ductwork, leading to a longer residence time for the PAC to adsorb mercury. Harding Street has a very short residence time, allowing for further comparison between the units. Higher temperature reduces mercury removal by PAC; these two units are the high and low extremes of the IPL system. Testing both temperatures allowed for a temperature relationship for mercury removal to be established.

Dry Sorbent Testing:

When found in the flue gas with concentrations of greater than 5 ppm, sulfur trioxide (SO_3) will compete with mercury for active sites on the PAC and reduce the overall Hg removal rate. To remove SO_3 from the flue gas, dry sorbents or sodium based solutions are injected into the flue gas ahead of the PAC injection. Because of its positive impact on ESP performance, Trona was selected over hydrated lime for SO_3 reduction at Petersburg. At Harding Street, the existing sodium-based solution (SBS) system was used to remove SO_3 to the target level of 3-5 ppmvd @ 3% O_2 at the AHGO.

Brominated Powdered Activated Carbon Testing:

For mercury removal, Calgon Carbon's brominated product (FLUEPAC MC PLUS) was injected into the flue gas. At Petersburg, the injection was downstream of the AH, and after the AHGO testing location. Harding Street's SBS system injects just downstream of the SCR, allowing for the PAC injection at the inlet of the air heater, which allowed a longer residence time for PAC and Hg to react. Brominated carbon was used for extra mercury oxidation, to assist in overall mercury removal.

Fuel Additive and Re-emission Additive Testing:

In addition to the PAC for mercury oxidation and removal, a Nalco fuel additive (MerControl 7895) was added to the coal at the feeders. The MerControl 7895, a calcium bromide solution, increases the oxidation of the mercury. Only oxidized mercury is captured by carbon; increasing the percentage of mercury that is oxidized increases the overall mercury reduction by PAC.

In past testing, Petersburg Unit 2 has been shown to have mercury re-emission from the FGD. Nalco also offers a re-emission chemical (MerControl 8034) that when injected into the FGD recycle slurry inhibits mercury re-emission. Originally, this chemical was to be tested along with PAC and fuel additive, but the equipment was unavailable at the time of testing, and the re-emission chemical could not tested. In order to support additives as a future potential use as a control technology, FGD wastewater samples were taken.

Test Plan:

Fuel Selection:

For the testing, [redacted] coal was used at both stations. [redacted] has been used in a coal blend at Petersburg in the past, but has not been a historical coal for Harding Street. The [redacted] coal has a medium to high mercury content but low chloride content. Chlorides in the coal aid in mercury oxidation, which in turn assists with mercury removal. Fuel data for the [redacted] mine are shown in Table 2. Actual coal data for the testing at Petersburg and Harding Street are shown in Appendix N of the report.

Table 2: Design Coal for Testing

Expected Coal [redacted]	
Ultimate Analysis (As Received)	
% Carbon	61.7
% Hydrogen	4.46
% Nitrogen	1.20
% Sulfur	2.93
% Oxygen	6.87
% Moisture	14.18
% Ash	8.64
HHV (Btu/lb)	11,282
Trace Elements (As Received)	
Chlorine (ppm)	195
Mercury (lb/TBtu)	7.29

Testing:

To determine the effects of sorbent and PAC injection on the units, extractive testing was performed along the flue gas path. Figures 1 and 2 show the testing locations for Petersburg and Harding Street, respectively. Speciated and total mercury were measured at the air heater gas inlet, the air heater gas outlet, the ESP outlet, and the stack. Filterable particulate matter (FPM) was measured at the air heater outlet, ESP outlet, and the stack. The full test protocol in Appendix K shows the locations and the EPA methods used in the testing.

In addition to the EPA methods, Nalco provided continuous mercury emission monitoring systems (MCEMS), which were used at the inlet and outlet of the FGD systems. These MCEMS provided a relative change and trend in the total and elemental mercury concentrations, and were used in determining if the system was stable for EPA method testing. Full flue-gas testing results are shown in Appendix J.

Figure 1: Petersburg Test Schematic

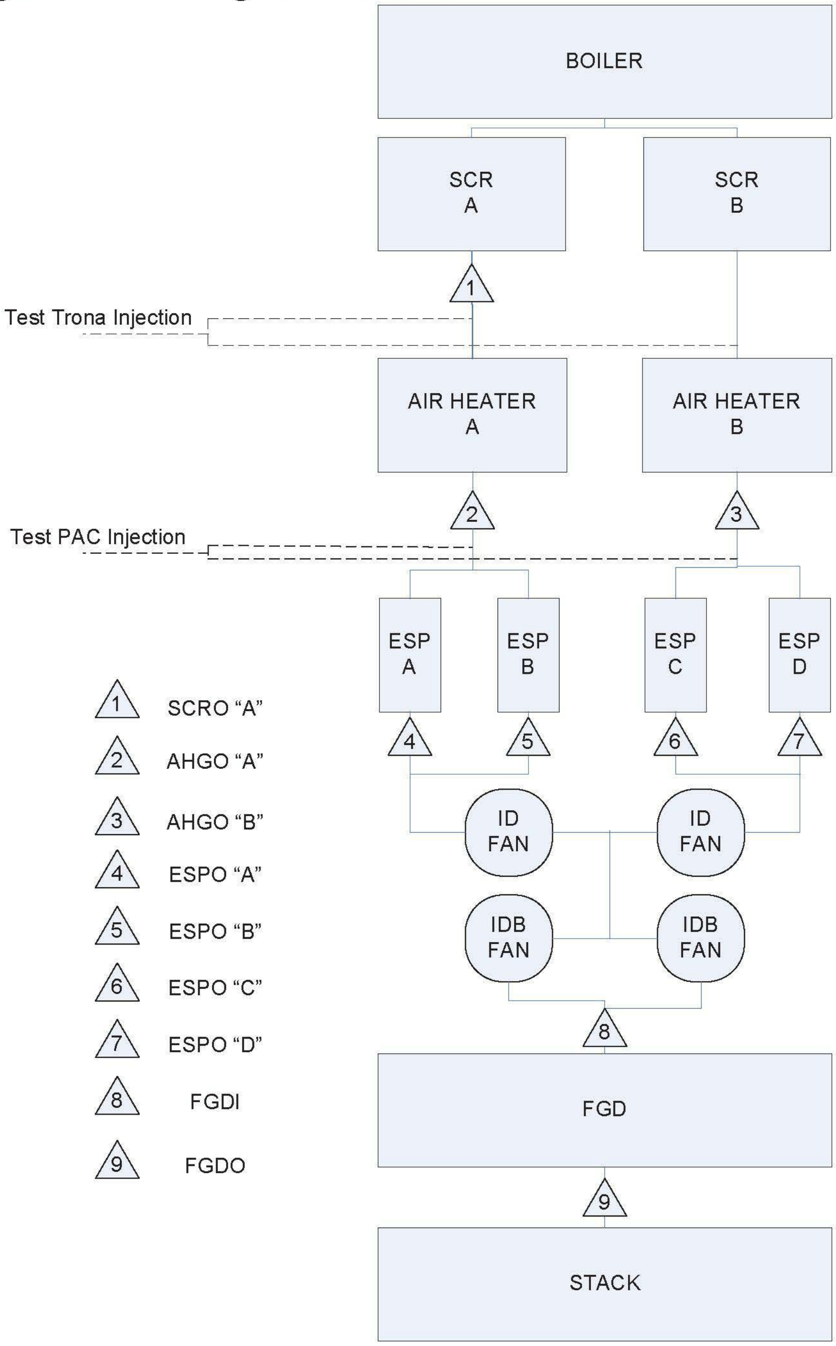
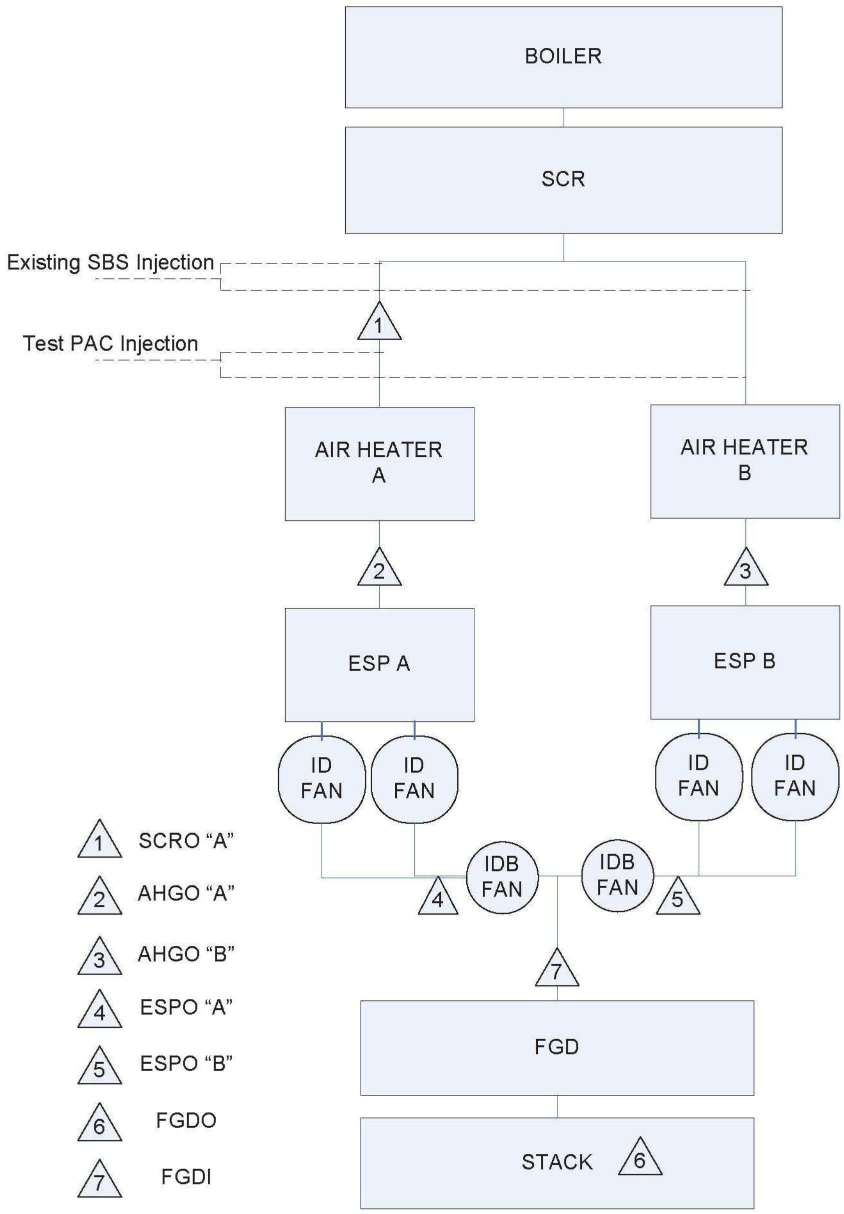


Figure 2: Harding Street Test Schematic



Schedule:

Testing was performed at Petersburg Station on March 8-15, 2012, and at Harding Street Station on March 19-24, 2012. The schedules for the testing at Petersburg and Harding Street are shown in Tables 3 and 4.

Table 3: Testing Schedule, Petersburg Station

		Run Numbers	Fuel Additive 7895	Trona	Brominated Activated Carbon (PAC)	Objective
3/8/12	Thursday					None. No Testing Conducted.
3/9/12	Friday					Scrubber Baseline Test: determine FGD Inlet and Outlet baseline Hg speciation and re-emission.
3/10/12	Saturday		X			Fuel Additive testing: evaluate the effect of fuel additive on Hg speciation.
3/11/12	Sunday	1-5				DSI/ACI Baseline Test: Determine native SO3 concentrations and Hg speciation.
3/12/12	Monday		X	X		DSI Injection: Determine Trona injection rate required to reach target SO3 of 3-5 ppm @ AHGO. Continue examining additive effects on Hg speciation and re-emission.
3/13/12	Tuesday	6-7	X	X	X	PAC Injection: Determine PAC injection rate to reach Hg concentrations of 1.2 lb/TBtu. Continue examining fuel additive effects on speciation.
3/14/12	Wednesday	8-11	X	X	X	PAC Injection: Determine PAC injection rate to reach Hg concentrations of 1.2 lb/TBtu and the ability of PAC to oxidize mercury without fuel additive.
3/15/12	Thursday	12-16		X	X	PAC Injection: Determine PAC injection rate to reach Hg concentrations of 1.2 lb/TBtu and the ability of PAC to oxidize mercury without fuel additive.

Table 4: Testing Schedule, Harding Street Station

		Run Numbers	Fuel Additive 7895	SBS	Brominated Activated Carbon (PAC)	Objective
3/19/12 (AM)	Monday			X		Scrubber Baseline Test: determine FGD Inlet and Outlet baseline speciation and re-emission.
3/19/12 (PM)				X		Fuel Additive Test: evaluate the effect of fuel additive on Hg speciation.
3/20/12	Tuesday		X	X		Fuel Additive: Evaluate the effect of fuel additive on Hg speciation.
3/21/12	Wednesday			X		SBS/ACI Baseline Test: Determine baseline speciations and concentrations.
3/22/12	Thursday		X	X	X	PAC Injection: Determine PAC injection rate to reach Hg concentrations of 1.2 lb/TBtu. Continue examining fuel additive effects on speciation.
3/23/12	Friday		X	X	X	PAC Injection: Determine PAC injection rate to reach Hg concentrations of 1.2 lb/TBtu and the ability of PAC to oxidize mercury without fuel additive.
3/24/12	Saturday			X	X	PAC Injection: Determine PAC injection rate to reach Hg concentrations of 1.2 lb/TBtu and the ability of PAC to oxidize mercury without fuel additive.

Petersburg 2 Results:

SO_3 Results:

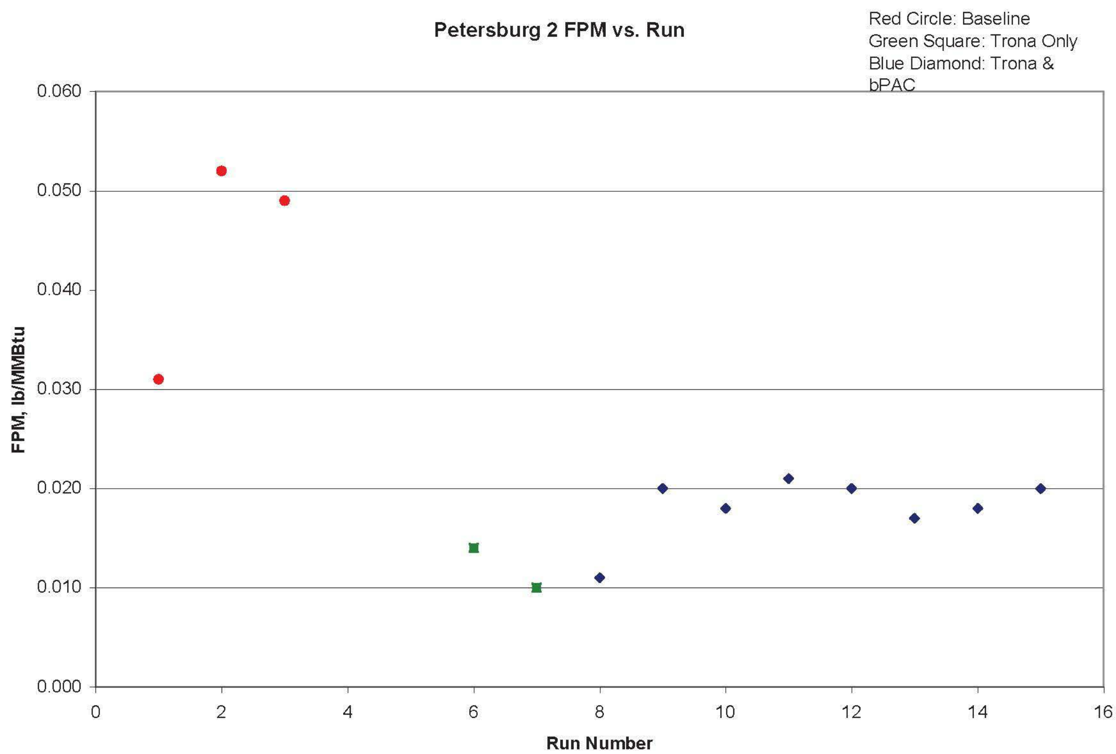
In order to meet the target of 3 ppmvd SO_3 at the AHGO, Trona was injected at the AHGI. Baseline testing indicated an untreated SO_3 level of 16-20 ppmvd @ 3% O_2.

Trona was initially injected at a rate of 3,500 lb/hr, which was iteratively adjusted to a feed rate of approximately 3,800 lb/hr. At the target feed rate, the SO_3 values ranged from 1.3-2.7 ppmvd corrected to 3% O_2. Full SO_3 results are shown in Appendix J.

FPM Results:

The final MATS Rule requires Petersburg Station to meet a filterable particulate limit of 0.030 lb/MMBtu. Stack FPM results are shown in Figure 3. Initial baseline testing indicated that Unit 2 was not reaching this limit with the existing controls, with a baseline FPM at the stack of 0.031-0.052 lb/MMBtu, shown in red. After Trona injection, the stack FPM limit is reduced to 0.01-0.014 lb/MMBtu, shown in green. After injection of PAC the FPM at the stack increases slightly to an average of 0.018, even with PAC injection rates greater than 7.5 lb/mmacf.

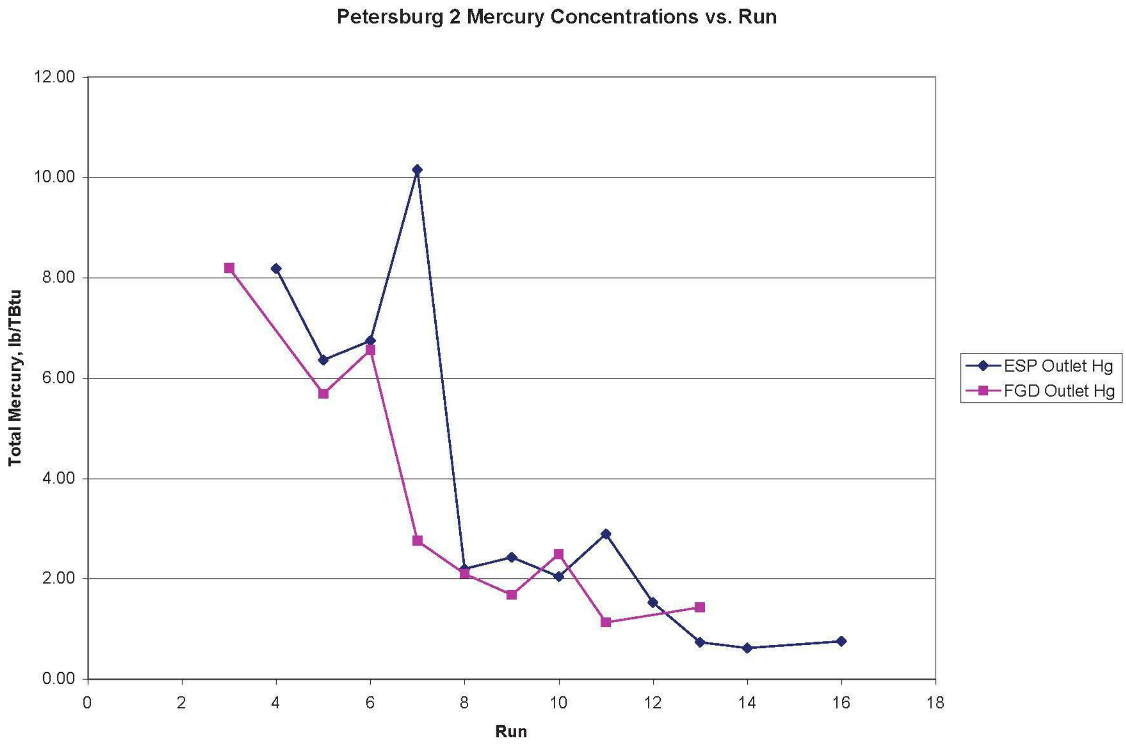
Figure 3: FPM vs. Run Number



Mercury Results:

Under the MATS Rule, Petersburg Unit 2 has a mercury limit of 1.2 lb/TBtu mercury as a single source, or less than an average of 1.0 lb/TBtu when averaged with other units. With ACI, Unit 2 was able to reach a minimum total mercury concentration of 0.62 lb/TBtu at the ESP outlet. At the higher PAC injection rates, the ESP outlet concentrations averaged 0.70 lb/TBtu. Figure 4 shows total mercury concentration for each run, as measured at the ESP outlet and the FGD outlet. The lower mercury concentration at the inlet to the FGD from the outlet is indication that re-emission is occurring.

Figure 4: Petersburg Mercury Concentrations vs. Run



Re-emission occurs when the FGD slurry tries to reach equilibrium with the entering flue gas. As mercury is removed prior to the FGD, the slurry will release mercury, and the phenomena are largely unknown. Oxidized mercury can be captured by the FGD, but elemental mercury is released.

Mercury oxidation is key to mercury removal. If more mercury is oxidized, there is more opportunity for the mercury to be removed. This testing used two approaches to oxidize the mercury: fuel additive and brominated carbon. Table 3 shows the average percent oxidation at the ESP outlet for each technology.

Table 3: Oxidation Profile at ESP Outlet, Petersburg Station

Technology	Average Oxidation, %
Baseline (no technology)	66.2
Fuel Additive	92.4
Trona + Fuel Additive	59.4
Trona + Fuel Additive + PAC	37.8
Trona + PAC	53.32

Harding Street:

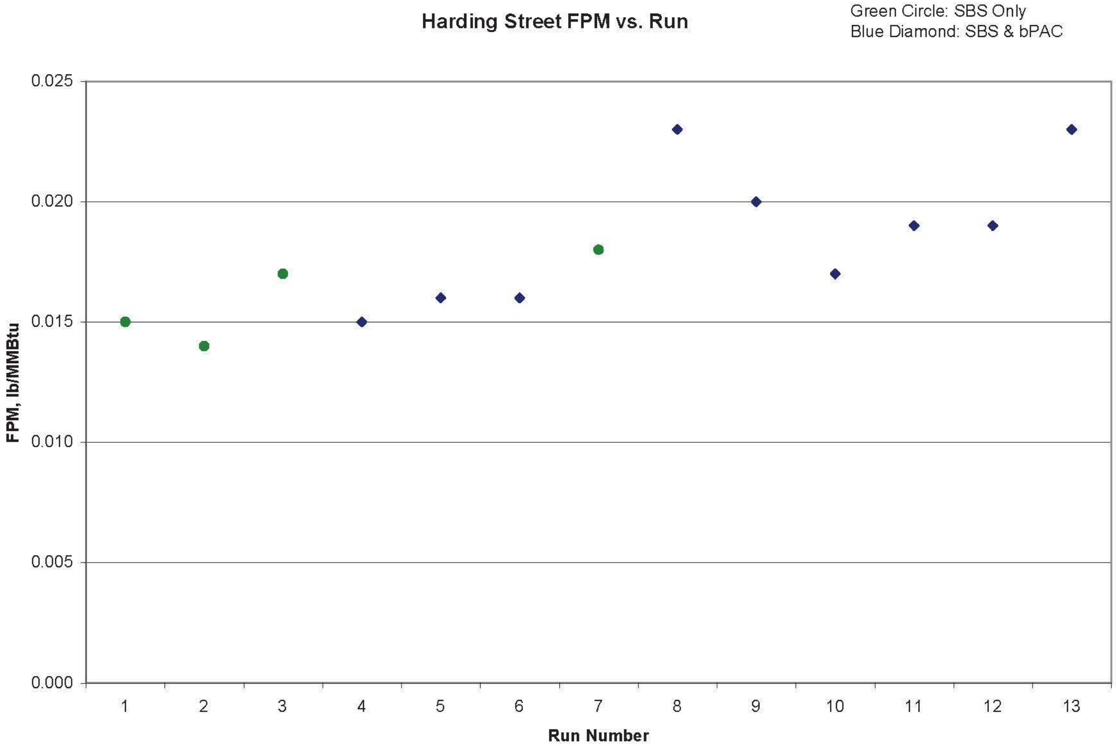
SO_3 Results:

Harding Street previously installed a permanent SBS system for SO_3 reduction. The SBS system removes SO_3 from the flue gas, and allows the unit to have lower condensable particulate matter, which results in lower total particulate matter emissions. During the baseline testing, the SO_3 at the air heater outlet was an average of 1.9 ppmvd @ 3% O_2, below the target level of 3-5 ppm.

FPM Results:

Harding Street will be required to meet an FPM limit of 0.030 lb/MMBtu at the stack. During baseline testing, with the SBS system in service, FPM at the stack averaged 0.015 lb/ MMBtu. With PAC injection, the average was 0.019 lb/ MMBtu. Figure 4 shows the change in FPM with each run. During the testing, Harding Street did not exceed the 0.030 lb/ MMBtu limit, even with a PAC injection at the maximum rate of 4.8 lb/mmacf. Figure 5 shows Harding Street FPM for each run.

Figure 5: Harding Street FPM vs. Run



Hg Results:

Under the MATS rule, Harding Street Unit 7 will have a mercury limit of 1.2 lb/TBtu. During the baseline testing, the stack mercury averaged 2.3 lb/TBtu, and during fuel additive and PAC injection, the mercury concentration never exceeded 1.0 lb/TBtu. Figure 5 shows ESP outlet and FGD outlet mercury concentrations for each run. The spike that occurred during Run 7 was a result of no PAC injection—Run 7 was used to verify the performance of fuel additive alone.

Figure 5: Harding Street Mercury Concentrations vs. Run

Similar to Petersburg, the percent oxidation at the ESP outlet was calculated for each technology and is shown in Table 4.

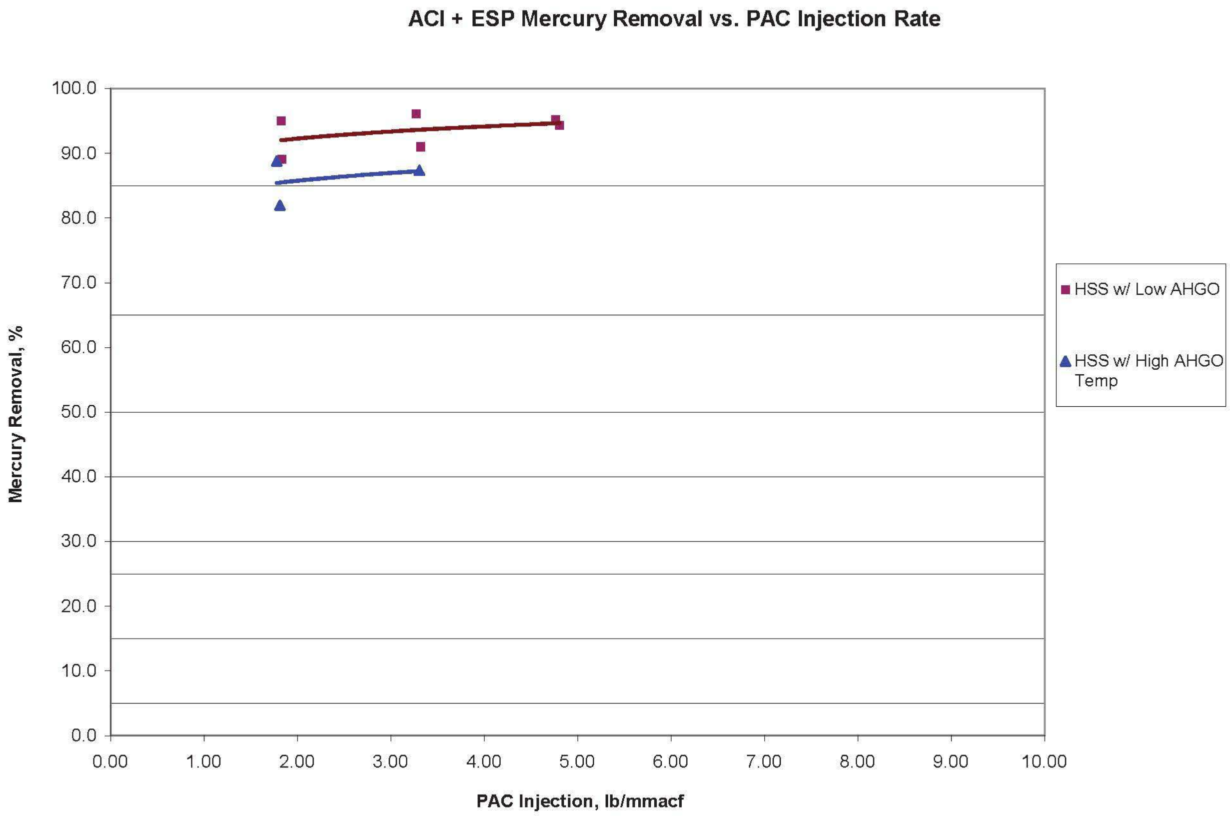
Table 4: Oxidation Profile at ESP Outlet, Harding Street Station

Technology	Average Oxidation, %
SBS	55.2
SBS + Fuel Additive	74.5
SBS + Fuel Additive + PAC	94.2
SBS + PAC	69.3

Appendix C
IPL Diagnostic Testing Summary
Attachment 1 - Air Heater Gas Outlet Temperature Effects on Hg Removal

During the diagnostic testing, Harding Street Unit 7 operated at AHGO temperature of approximately 300°F for most of the test, with an elevated temperature of 320°F for the final day of testing. The station purposely elevated the temperature to allow for the characterization of the Hg removal at higher temperatures. The two different temperatures were used to develop a correlation between temperature and Hg removal for Harding Street Unit 7. The testing showed a decrease of approximately 5-7% Hg removal efficiency at the elevated temperature, shown in Figure 1.

Figure 1: Temperature Effects on HSS7 Hg Removal



At an injection rate of 3 lbs/mmacf, approximately 93% Hg removal can be achieved with the ESP and ACI at 300°F, while approximately 87% Hg removal is achieved at the elevated temperature.

One year of Harding Street Unit 7 AHGO temperatures were analyzed to determine the expected temperature; AHGO temperature distributions are shown in Table 1.

Table 1: Harding Street Unit 7 AHGO Temperature Distributions

		AHGO <300°F			300°F < AHGO < 325°F			AHGO >325°F		
	Total	A	B	Avg	A	B	Avg	A	B	Avg
Yearly Operation:										
Annual Hours	7800	3672	1435	2133	3401	5652	5032	727	713	635
Annual Percent		47.1	18.4	27.3	43.6	72.5	64.5	9.3	9.1	8.1
Cold-Weather Operation:										
Dec 1-Feb 28 Hours	2078	882	40	38	962	1897	1906	234	141	134
Dec 1-Feb 28 Percent		42.4	1.9	1.8	46.3	91.3	91.7	11.3	6.8	6.4
Warm-Weather Operation:										
Jun 1-Aug 31 Hours	1371	719	531	628	617	736	681	35	104	62
Jun 1-Aug 31 Percent		52.4	38.7	45.8	45.0	53.7	49.7	2.6	7.6	4.5

For the year on the whole, the AHGO temperature is between 300°F and 325°F approximately 65% of the time, and below 300°F for approximately 27% of the time. During winter (Dec. 1-Feb. 28), the temperatures were between 300°F and 325°F over 91% of the time. Summer temperatures were between 300°F and 325°F for only 50% of the time.

S&L believes that the steam preheating system causes the winter AHGO temperatures to be higher than the summer AHGO temperatures. While this system is necessary to prevent condensation problems in the air heater, the higher temperatures will reduce mercury removal efficiencies. Assuming there are no negative effects downstream of the air heater, operating the steam heating system such that the AHGO temperatures are at or below 300°F will allow Harding Street Unit 7 to achieve MATS Hg compliance with less brominated PAC, and without the installation of a baghouse. If the AHGO temperature can be kept below 300°F, the 95% Hg removal estimate is still appropriate. If the temperatures between 300°F and 325°F are more likely, the estimated Hg removal efficiency at the same brominated PAC injection rate would be 92%. To reach 95% Hg removal with AHGO temperatures between 300°F and 325°F, a higher brominated PAC injection rate would be required. This change does not alter conclusions pertaining to the Harding Street Unit 7 control plan.

Appendix C
IPL Diagnostic Testing Summary
Attachment 2 – PAC Injection Effects on FGD Wastewater and Gypsum

Background

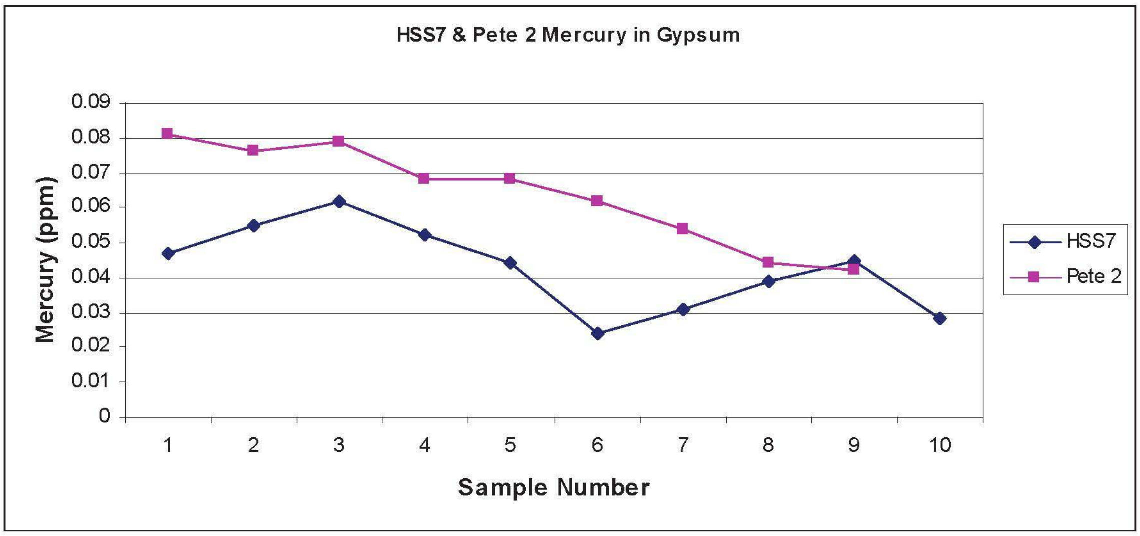
Powdered activated carbon (PAC) was injected during diagnostic testing at Harding Street Unit 7 and Petersburg Unit 2 for mercury removal. During the diagnostic testing, gypsum and FGD wastewater samples were taken during the baseline and during injection testing. Baseline testing was without any additives or PAC injection. These samples were analyzed for Hg.

Currently at Petersburg Unit 2 and Harding Street Unit 7, the FGD system is removing some percentage of the mercury (Hg) from the flue gas stream, <30% and <75% respectively. With PAC injection, Hg is removed from the flue gas prior to the FGD. In a long-term, steady-state condition with PAC injection, it is expected that a lower concentration of Hg entering the FGD will result in a lower concentration of Hg in both the FGD wastewater and the gypsum. PAC is expected to capture 80% to 90% of the Hg in the flue gas, and only an additional 2% to 5% will be captured in the FGD; therefore, PAC injection will reduce Hg in the FGD liquids and solids.

Mercury in Gypsum—Harding Street and Petersburg

Due to the short duration of the diagnostic testing and the batch operation of the gypsum systems, the systems did not reach steady state during the test period. The samples were pulled and analyzed to verify that there were no order-of-magnitude changes in the concentration in either direction. Figure 1 shows Hg concentration in the gypsum for Harding Street Unit 7 and Petersburg Unit 2 during the testing. Both units show a general decrease in Hg concentration, which would be expected as the PAC is capturing Hg prior to the FGD.

Figure 1: Mercury Concentrations in Gypsum—Harding Street Unit 7 and Petersburg Unit 2

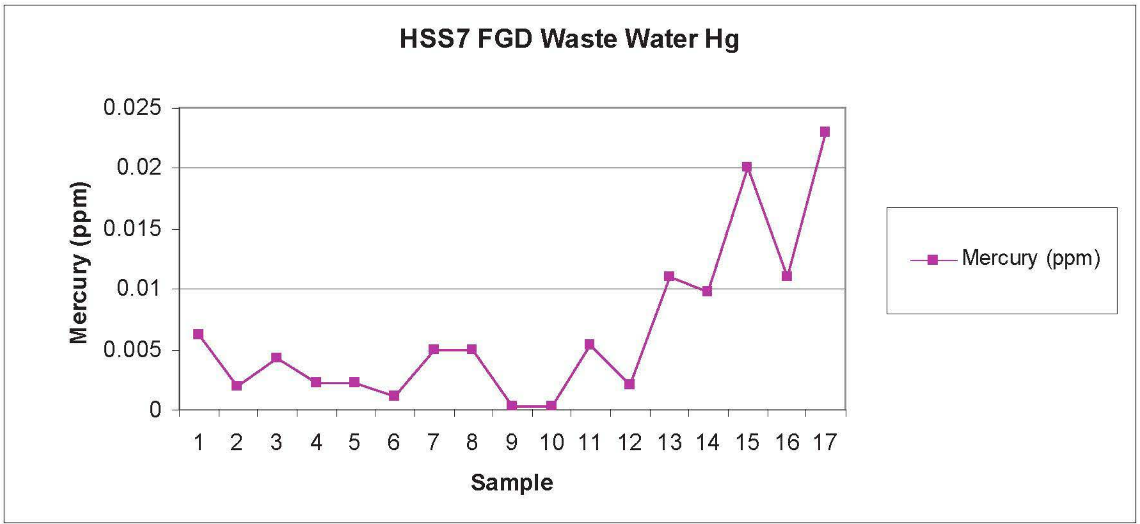


The typical lag time from absorber to gypsum varies for each unit, but is typically between 12 and 36 hours. While the gypsum sample cannot be correlated to specific PAC injection rate or time, the gypsum samples were taken at a time when impacts from the PAC injection would be seen. As the units did not reach steady state during the time when the samples were taken, a long-term Hg concentration cannot be predicted.

Mercury in FGD Wastewater—Harding Street

At Harding Street, FGD wastewater samples were taken and analyzed for Hg, and the results are shown in Figure 2.

Figure 2: FGD Wastewater Hg Concentrations—Harding Street

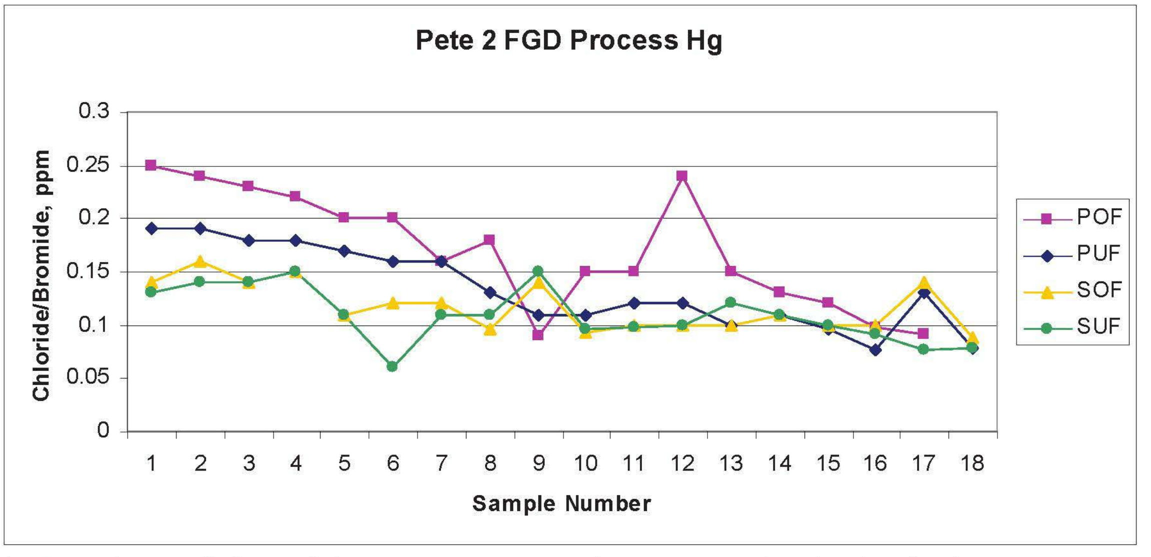


Harding Street Hg concentrations increase during the duration of the test, but that is believed to be the result of the fuel additive injection during the first two days of testing and the short duration of the test. The fuel additive oxidizes the mercury to enhance capture, and the FGD was removing more mercury than during baseline days. S&L believes the long-term FGD wastewater concentrations with PAC injection will be less than the baseline concentrations, but cannot predict the final equilibrium value.

Mercury in FGD Process Streams—Petersburg

Unlike Harding Street, at Petersburg, the hydroclone overflows and underflows were both sampled, as any of those four process flows can be discharged to the ash pond. Mercury concentrations for these four streams are shown in Figure 3. For these samples, the sample was well mixed, and the result is total Hg in the combination of liquid and solid samples. S&L recently received tests of each fraction, and will determine if Hg is concentrated in the liquid or solid fraction.

Figure 3: FGD Process Hg Concentrations—Petersburg



At Petersburg, all four of the process streams show a general reduction in the mercury, as expected. Because the samples were taken at a different point in the system than at Harding Street, it is difficult to determine what effect, if any, the fuel additive testing had on the Hg concentrations.

Conclusions

After analyzing the data from the Harding Street and Petersburg diagnostic testing, S&L believes that the mercury concentrations in both the gypsum and FGD wastewater will reach an equilibrium that is significantly less than current levels. Gypsum and wastewater Hg levels are reduced because Hg is captured by the PAC prior to the FGD, reducing the amount of Hg reaching the FGD. Due to the short-term and non-steady-state operation of the FGD and gypsum systems during the test, long-term equilibrium values cannot be predicted from these data.

APPENDIX D.
CAPITAL AND ANNUAL COST ESTIMATES

Appendix D
Capital and O&M Cost Estimates

Appendix D provides the backup documentation for the costs estimates summarized throughout the report. The appendix provides the following documents:

1. **Tabulation of the Capital with O&M costs for the recommended Emission Control Strategy**
2. **ESP vs. Baghouse costs tabulation for Petersburg Units 1 through 4 and Harding Street Unit 7**
3. **Basis for Petersburg Unit 2 and 3 detailed cost estimates**
4. **Work breakdown summary for the Unit 2 detailed cost estimates**
5. **Work breakdown summary for the Unit 3 detailed cost estimates**
6. **Cost estimate basis - Petersburg site arrangement**
7. **Cost estimate basis – Harding Street site arrangement**

GENERAL BASIS OF ESTIMATES

The capital cost estimates are based on conceptual arrangements. Generally less than 2% of the engineering has been completed to support Petersburg units 1 and 2 estimates and less than 1% of the engineering is completed to support the Petersburg Units 1, 4 and Harding Street Unit 7. The equipment and material quantities are based on preliminary engineering and designs completed for similar projects. Features common to all units include:

- Electrical estimates based on above-ground installation.
- Painting and Coating costs included in Piping.
- HVAC included in Architectural.
- Baghouse costs were based on recent proposals.
- I/O costs are based on an existing DCS at the unit and include only the cost is to expand this existing DCS for environmental improvements only.
- Equipment layouts as defined by the attached Petersburg Station and Harding Street Station general arrangements.

Unit unique data is described below:

Petersburg 2 and 3:

Detailed capital cost estimates for Petersburg Units 2 and 3 have been developed. The basis for the cost estimate and the detailed work breakdown structure to define the work scope is included in later sections of this appendix.

Petersburg 1:

- ESP upgrade costs based on input from conceptual ESP retrofit contractors to provide high frequency transformer rectifier (TR) sets.
- Ductwork and fan casing costs considering historical condition reports.
- ACI and DSI system costs based on equipment locations shown on the general arrangements.
- Increased escalation for Commercial Operation Q2/2015 @ 3%.
- Balance of plant costs to include ACI/DSI support steel, foundations, ductwork, piping, fire protection and electrical plus electrical for ESP upgrades
- WFGD improvements to include spare pumps and piping modifications so that the pumps can be changed out with the unit on line.
- Primary and back-up CEMS equipment to be installed in the primary and by-pass stacks

Petersburg 4:

- ESP upgrade costs based on input from conceptual ESP retrofit contractors to provide high frequency transformer rectifier (TR) sets.
- Ductwork costs.
- ACI and DSI system costs based on equipment locations shown on the general arrangements.
- Increased escalation to Commercial Operation Q4/2015 @ 3% per year.
- Balance of plant costs to include ACI/DSI support steel, foundations, ductwork, piping, fire protection and electrical plus electrical for ESP upgrades
- Primary and Back-up CEMS equipment to be installed in 1 stack

Harding Street 7:

- ESP costs are based on conceptual cost input from ESP retrofit contractors to increase the size of the box (vertical height addition with wider plate spacing.
- Increased escalation to Commercial Operation Q2/2016 @ 3% per year.
- SI costs to improve the system reliability.
- Includes costs to modify the ductwork into and out of the ESP to accommodate the new ESP height.
- Primary and Back-up CEMS equipment to be installed in 1 stack

- ACI system costs based on the equipment locations shown on the general arrangements.
- Balance of plant costs to include ACI support steel, foundations, ductwork, piping, fire protection and electrical plus electrical and HVAC for ESP modifications
- Heat tracing and winterization improvements for the WFGD to increase system reliability.
- Costs to wallpaper ductwork.

Cost Description	Pete Unit 1 -w- Existing ESP	Pete Unit 2 -w- New Baghouse	Pete Unit 3 -w- ESP & Polishing Baghouse	Pete Unit 4 -w- Existing ESP	HSS Unit 7 -w- Existing ESP
Capital (Equipment, Material & Labor)					
New Assets					
BH	NA	28,614,000	29,779,000	NA	NA
ESP Upgrades	950,000	NA	NA	1,750,000	24,500,000
Ductwork	NA	13,649,000	18,280,000	NA	5,300,000
Steel (Excluding Ductwork)	2,000,000	13,801,000	10,730,000	2,000,000	2,600,000
Fans	-	4,891,000	5,029,000	-	-
SI	3,070,000	3,315,000	3,360,000	3,890,000	400,000
ACI	1,230,000	1,182,000	1,357,000	1,620,000	1,200,000
CEMS (1.5 M per Stack system incl. Hg, HCL, FPM)	4,900,000	4,900,000	2,450,000	2,450,000	4,700,000
Electrical Equipment	600,000	5,249,000	6,869,000	600,000	600,000
BOP (Electrical, Air, Demo, Etc.)	4,823,000	28,970,000	21,030,000	3,660,000	4,000,000
BOP (Demo)	400,000	3,590,000	2,199,000	450,000	1,200,000
WFGD Upgrades	2,700,000	2,700,000	NA	NA	500,000
Relocation of Unit 3 BH to Flood Plain	-	-	NA	NA	NA
Other Direct and Const Indirect	4,842,000	29,738,000	27,639,000	3,846,000	10,539,000
Indirect Cost	3,876,100	15,466,000	14,159,000	3,613,100	6,109,000
Total Escalation	1,704,000	7,405,000	8,322,000	1,384,000	3,573,000
Total Contingency	6,064,000	20,661,000	19,436,000	4,899,000	12,330,000
Subtotal New Assets	37,159,100	184,131,000	170,639,000	30,162,100	77,551,000
Enhancements of Existing Assets					
ESP Enhancements	3,600,000		1,695,000	5,400,000	
Reduce Air Inleakage from Ducts	1,575,000	2,048,000	1,337,000	1,400,000	2,800,000
Reduce Air Inleakage from Fans	438,000	-	-	438,000	0
Subtotal Enhansements of Existing Assets	5,613,000	2,048,000	3,032,000	7,238,000	2,800,000
Total Project Costs	42,800,000	186,200,000	173,700,000	37,400,000	80,400,000
NPVRR Total Capital & Improved Assets	55,640,000	242,060,000	225,810,000	48,620,000	104,520,000
Other Costs					
Testing	325,000	325,000	325,000	325,000	325,000
Power Sales Lost Due to Outage	-	-	-		-
Variable O&M ($/yr)					
ACI					
ton/year	1,423	1,608	2,151	5,385	1,171
ton/year @ 82% Capacity Factor	1,167	1,319	1,764	4,416	960
ACI $ at $1790/ton	2,088,770	2,360,716	3,156,878	7,903,768	1,718,848
ACI Increased Ash Loading Disposal					
$	Insignificant	Base	Base	Insignificant	Insignificant
DSI					
ton/year - Trona	8,760	na	na	21,900	-
ton/year - Trona @ 82% Capacity Factor	6,920	na	na	17,301	-
DSI $ at $175/ton	1,211,070			3,027,675	-
ton/year - Hydrate Lime	na	6,570	7,884	na	na
ton/year - Hydrate Lime @ 82% Capacity Factor	na	5,387	6,465	na	na
DSI $ at $150/ton		808,110	969,732		
Fly Ash					
ton/year	-	na	na	145,514	-
$ @ IPL estimated disposal cost	-	na	na	2,776,000	-
Gypsum					
ton/year	-	na	na	-	-
$ @ 20/ton disposal cost	-	na	na	-	-
Auxiliary Power					
MWh	10,383	26,971	35,408	26,193	21,361
Auv Power $ at $35/MWh	363,417	943,976	1,239,292	916,763	747,638
Bags					
$	na	486,720	459,680	na	na
Misc. Operating Repairs	Base	Base	Base	Base	Base
WFGD Dismister Packing Replaced More Frequently	150,000	150,000	150,000	150,000	150,000
Years of Escalation	4	4	4	4	4
Fixed O&M ($/yr)					
WFGD (Increased Ash Loading) $	150,000	na	na	150,000	150,000
$					
Operations & Maintanence Labor - New Equipment					
CEMS	800,000	800,000	400,000	400,000	650,000
ACI/DSI	45,000	45,000	45,000	45,000	45,000
Ductwork $	150,000	na	na	150,000	150,000
$ Total Annual O&M (first year cost)	4,958,257	5,594,522	6,420,582	15,519,206	3,611,486
$ Total Annual O&M with escalation (2016$)	5,580,562	6,296,684	7,226,422	17,467,003	4,064,759
$ NPVRR Annual Total O&M	71,769,517	80,979,292	92,936,309	224,636,588	52,275,347
NPVRR Future ESP Enhancements in Year 7, 14	3,489,077	-	1,356,238	5,289,891	-
$ NPVRR Total Capital, Other and O&M	$131,000,000	$323,000,000	$321,000,000	$279,000,000	$157,000,000

Summary of Capital, Annual, and NPV Costs - All Options Considered

Cost Description	Pete Unit 1 -w- New Baghouse	Pete Unit 1 -w- Existing ESP	Pete Unit 2 -w- New Baghouse	Pete Unit 2 -w- Existing ESP	Pete Unit 3 -w- ESP & Polishing Baghouse	Pete Unit 3 -w- Existing ESP	Pete Unit 4 -w- ESP & Polishing Baghouse	Pete Unit 4 -w- Existing ESP	HSS Unit 7 -w- New Baghouse	HSS Unit 7 -w- Existing ESP
Capital (Equipment, Material & Labor)										
New Assets										
BH	20,249,166	NA	28,614,000	NA	29,779,000	NA	30,000,000	NA	32,722,377	NA
ESP Upgrades	NA	950,000	NA	33,446,644	NA	1,750,000	NA	1,750,000	NA	24,500,000
Ductwork	9,658,939	NA	13,649,000	NA	18,280,000	NA	23,651,340	NA	15,608,713	5,300,000
Steel (Excluding Ductwork)	9,766,504	2,000,000	13,801,000	2,000,000	10,730,000	2,000,000	12,730,000	2,000,000	10,730,000	2,600,000
Fans	3,461,196	-	4,891,000	-	5,029,000	-	5,029,000	-	4,891,000	-
SI	3,100,000	3,070,000	3,315,000	3,400,000	3,360,000	3,890,000	3,890,000	3,890,000	400,000	400,000
ACI	1,100,000	1,230,000	1,182,000	1,182,000	1,357,000	1,357,000	1,620,000	1,620,000	1,200,000	1,200,000
CEMS (1.5 M per Stack system incl. Hg, HCL, FPM)	4,900,000	4,900,000	4,900,000	4,900,000	2,450,000	2,450,000	2,450,000	2,450,000	4,700,000	4,700,000
Electrical Equipment	4,464,541	600,000	5,249,000	600,000	6,869,000	600,000	6,869,000	600,000	5,249,000	600,000
BOP (Electrical, Air, Demo, Etc.)	21,928,618	4,823,000	28,970,000	3,660,000	21,030,000	3,660,000	26,330,000	3,660,000	40,352,896	4,000,000
BOP (Demo)	1,113,000	400,000	3,590,000	500,000	2,199,000	500,000	2,199,000	450,000	1,400,000	1,200,000
WFGD Upgrades	2,700,000	2,700,000	2,700,000	2,700,000	NA	NA	NA	NA	500,000	500,000
Relocation of Unit 3 BH to Flood Plain	-	-	-	8,000,000	NA	NA	NA	NA	NA	NA
Other Direct and Const Indirect	20,955,923	4,842,000	29,738,000	15,338,716	27,639,000	4,119,657	29,172,964	3,846,000	29,931,886	10,539,000
Indirect Cost	11,373,767	3,876,100	15,466,000	8,330,010	14,159,000	3,613,000	15,833,544	3,613,100	16,245,446	6,109,000
Total Escalation	6,458,825	1,704,000	7,405,000	4,328,955	8,322,000	1,347,215	9,192,957	1,384,000	9,502,066	3,573,000
Total Contingency	22,954,331	6,064,000	20,661,000	16,811,474	19,436,000	4,787,931	31,954,970	4,899,000	32,786,264	12,330,000
Subtotal New Assets	144,184,809	37,159,100	184,131,000	105,197,797	170,639,000	30,074,804	200,922,775	30,162,100	206,219,648	77,551,000
Enhancements of Existing Assets										
ESP Enhancements		3,600,000		5,091,938	1,695,000	3,780,000	1,695,000	5,400,000		
Reduce Air Inleakage from Ducts	1,575,000	1,575,000	2,048,000	2,896,747	1,337,000	1,337,000	1,400,000	1,400,000	780,436	2,800,000
Reduce Air Inleakage from Fans	-	438,000	-	619,600	-	438,000	-	438,000	-	0
Subtotal Enhansements of Existing Assets	1,575,000	5,613,000	2,048,000	8,608,285	3,032,000	5,555,000	3,095,000	7,238,000	780,436	2,800,000
Total Project Costs	145,800,000	42,800,000	186,200,000	113,800,000	173,700,000	35,600,000	204,000,000	37,400,000	207,000,000	80,400,000
NPVRR Total Capital & Improved Assets	189,540,000	55,640,000	242,060,000	147,940,000	225,810,000	46,280,000	265,200,000	48,620,000	269,100,000	104,520,000
Other Costs										
Testing	325,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000
Power Sales Lost Due to Outage	-	-	-	-	-	-	6,006,336		-	-
Variable O&M ($/yr)										
ACI										
ton/year	569	1,423	1,608	4,021	2,151	4,660	2,154	5,385	586	1,171
ton/year @ 82% Capacity Factor	467	1,167	1,319	3,297	1,764	3,821	1,766	4,416	480	960
ACI $ at $1790/ton	835,508	2,088,770	2,360,716	5,901,789	3,156,878	6,839,903	3,161,507	7,903,768	859,424	1,718,848
ACI Increased Ash Loading Disposal										
$	Base	Insignificant	Base	Insignificant	Base	Insignificant	Base	Insignificant	Base	Insignificant
DSI										
ton/year - Trona	na	8,760	na	17,958	na	21,900	na	21,900	na	-
ton/year - Trona @ 82% Capacity Factor	na	6,920	na	14,187	na	17,301	na	17,301	na	-
DSI $ at $175/ton		1,211,070		2,482,694		3,027,675		3,027,675		-
ton/year - Hydrate Lime	3,066	na	6,570	na	7,884	na	7,884	na	na	na
ton/year - Hydrate Lime @ 82% Capacity Factor	2,514	na	5,387	na	6,465	na	6,465	na	na	na
DSI $ at $150/ton	377,118		808,110		969,732		969,732			
Fly Ash										
ton/year	na	-	na	-	na	145,251	na	145,514	na	-
$ @ IPL estimated disposal cost	na	-	na	-	na	2,776,000	na	2,776,000	na	-
Gypsum										
ton/year	na	-	na	-	na	-	na	-	na	-
$ @ 20/ton disposal cost	na	-	na	-	na	-	na	-	na	-
Auxiliary Power										
MWh	14,390	10,383	26,971	19,559	35,408	26,155	36,105	26,193	29,477	21,361
Auv Power $ at $35/MWh	503,638	363,417	943,976	684,552	1,239,292	915,420	1,263,671	916,763	1,031,688	747,638
Bags										
$	258,394	na	486,720	na	459,680	na	459,680	na	532,100	na
Misc. Operating Repairs	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base
WFGD Dismister Packing Replaced More Frequently	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Years of Escalation	4	4	4	4	4	4	4	4	4	4
Fixed O&M ($/yr)										
WFGD (Increased Ash Loading) $	na	150,000	na	150,000	na	150,000	na	150,000	na	150,000
$										
Operations & Maintanence Labor - New Equipment										
CEMS	800,000	800,000	800,000	800,000	400,000	400,000	400,000	400,000	650,000	650,000
ACI/DSI	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Ductwork $	na	150,000	na	150,000	na	150,000	na	150,000	na	150,000
$ Total Annual O&M (first year cost)	2,969,658	4,958,257	5,594,522	10,364,034	6,420,582	14,453,999	6,449,591	15,519,206	3,268,212	3,611,486
$ Total Annual O&M with escalation (2016$)	3,342,376	5,580,562	6,296,684	11,664,812	7,226,422	16,268,103	7,259,071	17,467,003	3,678,402	4,064,759
$ NPVRR Annual Total O&M	42,985,048	71,769,517	80,979,292	150,016,781	92,936,309	209,217,983	93,356,195	224,636,588	47,306,547	52,275,347
NPVRR Future ESP Enhancements in Year 7, 14	-	3,489,077	-	-	1,356,238	2,104,701	2,425,471	5,289,891	-	-
$ NPVRR Total Capital, Other and O&M	$233,000,000	$131,000,000	$323,000,000	$298,000,000	$321,000,000	$258,000,000	$369,000,000	$279,000,000	$317,000,000	$157,000,000

Sargent & Lundy LLC

Indianapolis Power & Light
Petersburg Unit 2 - 471MW, Unit 3 – 574MW
Baghouse, ACI & DSI Backfit

06/20/12
Rev. C for Unit 2, Rev A for Unit 3

BASIS OF COST ESTIMATE

Project No.: 10572-060
Estimate No. U2 - 31411C, U3 – 31687A
Preparer: J. Evanchik, G. Amen

General Information

Type of Estimate – Conceptual

Cost Estimate is for the installation of a new Baghouse, Activated Carbon Injection system; (ACI) and a Dry Sorbent Injection System, (DSI), at the Petersburg Station Unit 2 and 3. A new UAT Transformer and the replacement of the existing booster fans with two new 7000HP Booster Fans are required for this work.

Project location – Evansville, IN
Unit of measurement in cost estimate – Imperial, US
Currency – USD
Unique site issues – Existing plant.
Contracting strategy – Multiple Lump Sum

Construction

Labor profile; Union craft for Evansville, IN

Labor wage rate selected for the estimate - 2012 rates are as published in RS Means Labor Rates for the Construction Industry, 2012 Edition. The craft rates are then incorporated into work crews appropriate for the activities by adding allowances for small tools, construction equipment, insurance, and site overheads to arrive at crew rates detailed in the cost estimate. Regional labor productivity multiplier 1.10 is included based on Compass International Global Construction Yearbook.

Labor Work Schedule and Incentives:

- Overtime allowances have been made for a 5x10 workweek schedule for non-outage work. An overtime inefficiency factor of 8% is accounted for in overtime pay calculations. It is assumed that 95% of total labor hours will be spent during the non-outage work..
- For outage work, overtime allowances have been made for a 7x10 workweek schedule. An overtime inefficiency factor of 21% is accounted for in overtime pay calculations. It is assumed that 5% of total labor hours will be spent during the outage.

Procurements – Cost Basis

- Baghouse pricing is based on firm vendor pricing.

Project Indirect Costs

- Heavy Construction Equipment: Crane costs included as a separate line item.
- Mobilization / Demobilization: included with the crew wage rates. It is based on 1.25% of total direct labor cost.
- Scaffolding: Included at 5% of total direct labor cost.
- Consumables: 0.5% of equipment/materials cost.
- Per-diem subsistence: Included at $10/hr or 10.6% of total direct labor cost.
- Contractor's G&A and Profit: G&A at 10% and Profit at 5% of total direct material and labor costs.
- Freight: A separate line item is included at 5% of total direct material cost. The Equipment costs include freight.
- Construction Management: Included at 2% of total direct and construction indirect costs.
- Start-up and Commissioning: Included at 1% of total direct and construction indirect costs.
- Engineering: Included at 8% of total direct and construction indirect costs.

Escalation

- For the entire duration of the project, future Cost Escalation is averaged at 4.6% for Unit 2 and 5.7% for Unit 3 and it is based on an assumed cash flow per the project schedule.

Contingency

- Based on performing range estimating for Unit 2 and Unit 3 and at 95% confidence factor that the project will not run over budget, the contingency for Unit 2 is set at 13.5% and 13.6% for Unit 3. These percentages are applied on total equipment, material, labor and indirect costs.
- Please see range estimating files for the ranges assigned to each account.

Scope Excluded or By Others

- Owner's Costs
    - Owners monitoring staff costs
    - Permitting/Purchasing/Accounting support
    - Startup labor
    - Permit fee's
    - Lubricants/oils for equipment
    - Compliance Testing
- Bond Costs
- AFUDC
- Asset retirement costs
    - Unit 1 fly ash transfer station
    - Unit 2 ESP
    - Unit 2 & 3 Transformers (Unit 2 are planned as spare stores)
    - Unit 2 & 3 ID Booster Fans and motors.

- Obsolete inventory for the following;
  - ESP TR sets (only Unit 3 existing TR's will remain)
  - Unit 2 hydovactor
  - Unit 2 ESP
  - Unit 2 and Unit 3 Booster Fan and auxiliary equipment
  - Unit 2 ESP fly ash hopper valves and piping
- Modifications to reduce Air Heater Gas Outlet temperatures
- DCS Addition on Unit 2 and 3. (MATS will provide input for interfaces change but not for the DCS additions currently planned for this period.
- An arc-flash improvement for existing electrical equipment is not included.
- Spare Parts except as noted above for baghouse
- Sales Taxes
- EPC fee's
- Lost power during outages
- Construction utilities (assumes contractor's won't be charged for air, water or power)
- Boiler, SCR, ESP reinforcing for transient pressure conditions.
- Asbestos Abatement

Scope with Limited Definition

- Quantities are included for Mechanical piping and electrical cabling for above ground interferences.
- Quantities also included for Mechanical piping and electrical cabling for below ground interferences.
- Lead Paint Abatement.
- Field touch-up Steel Painting & Coating.
- Structure reinforcing costs for framing and ductwork.
- Auxiliary power interconnects with switchyard.
- Arc-flash upgrades are not required
- Boiler NFPA upgrades are not required

Estimate No; 31411C
Project No; 10572-060
Issue Date: 06/20/12

Indianapolis Power and Light Company
Petersburg Unit 2 Baghouse, ACI-DSI
Conceptual Cost Estimate

Sargent & Lundy, LLC

Group	Description	Total Amount
11.00.00	DEMOLITION	$3,589,562
21.00.00	CIVIL WORK	$2,525,293
22.00.00	CONCRETE	$2,555,256
23.00.00	STEEL	$26,066,048
24.00.00	ARCHITECTURAL	$2,787,160
27.00.00	PAINTING & COATING	$284,625
31.00.00	MECHANICAL EQUIPMENT	$40,664,005
33.00.00	MATERIAL HANDLING EQUIPMENT	$1,821,718
34.00.00	HVAC	$817,220
35.00.00	PIPING	$2,841,922
36.00.00	INSULATION	$2,934,490
41.00.00	ELECTRICAL EQUIPMENT	$6,477,535
42.00.00	RACEWAY, CABLE TRAY & CONDUIT	$4,157,570
43.00.00	CABLE	$3,447,320
44.00.00	CONTROL & INSTRUMENTATION	$6,391,767
61.00.00	CONSTRUCTION INDIRECT	$3,000,000
71.00.00	PROJECT INDIRECT	$500,000
91.00.00	CONSTRUCTION INDIRECTS	$29,738,300
93.00.00	PROJECT INDIRECTS	$15,466,000
94.00.00	CONTIGENCY	$20,660,500
96.00.00	ESCALLATION	$7,404,800
98.00.00	INTREST DURING CONSTRUCTION (AFUDC)	$0
	TOTAL PROJECT COSTS	$184,131,091

Estimate No.: 31411
Project No.: 10572-060
Issue Date: 06/20/12

Indianapolis Power & Light Company
Petersburg Unit 2 Baghouse, ACI-DSI
Conceptual Cost Estimate

Group	Phase	Description	Notes
11.00.00		**DEMOLITION**	
	11.21.00	**Demolition, Civil Work**	
		Disposal	Disposal - rubbish from demolition
		Demolition, Civil Work	
	11.23.00	**Demolition, Steel**	
		Steel	Miscellaneous
		Steel	Allowance to remove duct above booster fans
		Steel	Allowance relocation at duct locations
		Demolition, Steel	
	11.27.00	**Demolition, Painting & Coating**	
		Painting & Coating	Lead paint abatement allowance, piping and stuctural steel, Original Unit 3 vintage.
		Demolition, Painting & Coating	
	11.31.00	**Demolition, Mechanical Equipment**	
		Remove and relocate existing water tanks	
		Allowance to remove booster fans	
		Remove hydroveyor system on top of U2 ESP,	
		Demo existing booster fans and lube oil skids	
		Demo existing Unit 2 ESP ash handling collection piping from hoppers.	
		Above ground mechanical demo, including piping - Allowance	
		Under ground mechanical demo/relocation, including piping - Allowance	
		Demolish U2 ESP, Subcontract cost	
		Demolition, Mechanical Equipment	
	11.41.00	**Demolition, Electrical Equipment**	
		Remove (2) Existing 4500HP/4KV ID Booster Fan Motors	
		18/24 MVA, Transformer (Oil filled outdoor)	Existing UAT-2B, GAT-2
		Modify & Reterminate Existing ID Fan 2-2 Power Feed to new 6.9KV switchgear	Included in new switchgear
		Demolition, Electrical Equipment	
	11.42.00	**Demolition, Raceway, Cable Tray, & Conduit**	
		3" RGSConduit	
		3" Sealtite flex conduit,	
		Demolition, Raceway, Cable Tray, & Conduit	
	11.43.00	**Demolition, Cable**	
		2 booster fans lube oil & blower skids	
		Ash handling vacuum exhausters	
		Demolition, Cable	
		DEMOLITION	
21.00.00		**CIVIL WORK**	
	21.17.00	**Earthwork, Excavation**	
		Backfill, Foundation - select structural fill	Backfill at riverbank for ACI/DSI silo area.
		Earthwork, Excavation	
	21.17.15	**Earthwork, Excavation & Backfill, Foundation**	
		Earthwork, Excavation, Foundation	3 existing, relocated tanks
		Earthwork, Excavation, Foundation	Booster fan mods
		Earthwork, Excavation, Foundation	Misc Equipment Supports
		Earthwork, Excavation, Foundation	ACI elect/mech bld foundation
		Earthwork, Excavation, Foundation	ACI silo foundation
		Earthwork, Excavation, Foundation	Ash convey pipe foundations
		Earthwork, Excavation, Foundation	Baghouse foundations,
		Earthwork, Excavation, Foundation	Duct support foundation
		Earthwork, Excavation, Foundation	DSI Silo foundation
		Earthwork, Excavation, Foundation	Excavation at riverbank for ACI/DSI silo area.
		Earthwork, Excavation, Foundation	Ash convey equipment.
		Earthwork, Excavation & Backfill, Foundation	
	21.17.35	**Earthwork, Excavation, Trench**	
		Earthwork, Excavation, Trench	Potable water header to baghouse riser
		Earthwork, Excavation, Trench	
	21.19.15	**Earthwork, Disposal of Excess Material**	
		Earthwork, Disposal of Excess Material	3 existing, relocated tanks
		Earthwork, Disposal of Excess Material	Booster fan mods
		Earthwork, Disposal of Excess Material	Misc Equipment Supports
		Earthwork, Disposal of Excess Material	ACI elect/mech bld foundation

Group	Phase	Description	Notes
		Earthwork, Disposal of Excess Material	ACI silo foundation
		Earthwork, Disposal of Excess Material	Ash convey pipe foundations
		Earthwork, Disposal of Excess Material	Baghouse foundations,
		Earthwork, Disposal of Excess Material	Duct support foundation
		Earthwork, Disposal of Excess Material	DSI Silo foundation
		Earthwork, Disposal of Excess Material	At riverbank for ACI/DSI silo area
		Earthwork, Disposal of Excess Material	Ash convey equipment
		Earthwork, Disposal of Excess Material	
	21.43.00	**Fencework**	
		Fencework - Security Fence, 10 ft tall, posts set in concrete	
		Fencework	
	21.53.00	**Piling & Caisson**	
		Auger cast piles, 18" dia. X 40' long	ACI/DSI silo foundation
		Micro Pile 10" dia. X 50' long	Booster fan mods
		Auger cast piles, 18" dia. X 40' long	Baghouse
		Sheet piling - 45' high	
		Pile load test	
		Mobilization / demobilization	
		Micro Pile 8" dia. X 50' long, low head	Duct support foundation
		Piling & Caisson	
	21.57.00	**Road, Parking Area, & Surfaced Area**	
		Asphalt road, 24 ft wide 6" thk	
		4" gravel surfacing	Construction laydown
		New gravel road - 16' wide , 4" thick	New access road to U1/U2 intake structure
		Road, Parking Area, & Surfaced Area	
	21.67.00	**Survey**	
		SURVEY	
		Survey	
	21.68.00		
		GEOPHYSICAL INVESTIGATION	
		21.68.00	
		CIVIL WORK	
22.00.00		**CONCRETE**	
	22.13.00	**Concrete**	
		3 existing, relocated tanks	
		Transformer pad mods	
		ACI elect/mech bld foundation	
		ACI silo foundation	
		Ash convey pipe foundations	
		Baghouse foundations,	
		Duct support foundation	
		Booster fan mods	
		Misc Equipment Supports	
		DSI Silo foundation	
		New ACI/DSI silo area	
		Ash convey equipment	
		For widening main access road	
		Concrete	
	22.13.23	**Concrete, Elevated Slab, Separate Finished Floor**	
		Concrete, Elevated Slab, Separate Finished Floor-elevated slab 4500 psi	
		Concrete, Elevated Slab, Separate Finished Floor	
	22.15.00	**Embedment**	
		Allow for dowels in new conc. slab at riverbank	
		3 existing, relocated tanks	
		Transformer pad	
		ACI elect/mech bld foundation	
		ACI silo foundation	
		Ash convey pipe foundations	
		Baghouse foundations,	
		Duct support foundation	
		Booster fan mods	
		Misc Equipment Supports	

Group	Phase	Description	Notes
		DSI Silo foundation	
		Baghouse elevated floor slab 6"	
		New ACI/DSI silo area	
		Ash convey equipment	
		For widening main access road	
		Embedment	
	22.17.00	**Formwork**	
		3 existing, relocated tanks	
		Transformer pad	
		ACI elect/mech bld foundation	
		ACI silo foundation	
		Ash convey pipe foundations	
		Baghouse foundations,	
		Duct support foundation	
		Booster fan mods	
		Misc Equipment Supports	
		DSI Silo foundation	
		New ACI/DSI silo area	
		Ash convey equipment	
		For widening main access road	
		Formwork	
	22.21.00	**Concrete, Miscellaneous**	
		Existing booster fan pedestal	
		Concrete, Miscellaneous	
	22.25.00	**Reinforcing**	
		3 existing, relocated tanks	
		Transformer pad	
		ACI elect/mech bld foundation	
		ACI silo foundation	
		Ash convey pipe foundations	
		Baghouse foundations,	
		Duct support foundation	
		Booster fan mods	
		Misc Equipment Supports	
		DSI Silo foundation	
		Baghouse elevated floor slab 6"	
		Reinforcing	
		CONCRETE	
23.00.00		**STEEL**	
	23.15.00	**Ductwork**	
		Mandoor for ductwork	Baghouse inlet
		Mandoor for ductwork	Baghouse outlet
		Sliding plate bearing assembly	Baghouse inlet
		Sliding plate bearing assembly	Baghouse outlet
		Existing ductwork modifications	Baghouse inlet and outlet
		Ductwork - Panel construction	Baghouse inlet and outlet
		Ductwork turning vanes	Air heater to Baghouse, in existing duct at AH outlet
		Ductwork turning vanes	Baghouse to ID fan, in existing duct at ID fan inlet
		Replace ductwork	Booster tio ID fan
		Bypass duct	Bypass duct steel
		Ductwork	
	23.17.00	**Gallery**	
		Swing gates	Duct support steel
		Handrail with guardplate	Duct support steel
		Grating	Fan area
		Ladders with safety cages	Duct support steel
		Stairs and pipe railing, # of treads	Duct support steel
		Grating	Duct access
		Grating	Baghouse Area
		Piperack and galleries	ACI/DSI
		Gallery	
	23.23.00	**Steel,Miscellaneous**	

Group	Phase	Description	Notes
		Steel,Miscellaneous	Reinforcement of ESP and SCR and duct work from AH to outlet to ID fan inlet - Not Included.
		Steel,Miscellaneous	
	23.23.23	**Decking, Metal**	
		Decking, Metal	Baghouse elevated floor slab
		Decking, Metal	
	23.25.00	**Rolled Shape**	
		Structural Steel	Framing for baghouse penthouse and hopper enclosure supplied by baghouse supplier
		Channel girts & sag rods	Baghouse penthouse and hopper enclosure
		Channel girts & sag rods	Electrical equipment enclosure
		Channel girts & sag rods	Air compressor enclosure
		Structural Steel	Misc Equipment Supports
		Structural Steel	Ash convey pipe supports
		Structural Steel	Misc access galleries
		Structural Steel	Duct support steel air heater to baghouse
		Structural Steel	Duct support steel baghouse to ID fan
		Structural Steel	Baghouse support structure, stair tower and elevator
		Structural Steel	ID fan casing reinforcement for new operating and transient pressures. Allowance.
		Structural Steel	Cable tray UAT 2A to baghouse fans
		Structural Steel	ACI/DSI piperack and galleries
		Rolled Shape	
		STEEL	
24.00.00		**ARCHITECTURAL**	
	24.15.00	**Door (Incl. Frame & Hardware)**	
		Sectional vertical lift door, motorized, 10' x 12'	Baghouse hopper enclosure
		Insulated door & frame, 3' x 7'	Electrical equipment enclosure
		Insulated double door & frame, 6' x 7'	Electrical equipment enclosure
		Insulated door & frame, 3' x 7'	Air compressor enclosure
		Insulated double door & frame, 6' x 7'	Air compressor enclosure
		Insulated door & frame, 3' x 7'	Baghouse penthouse
		Insulated double door & frame, 6' x 7'	Baghouse penthouse
		Insulated door & frame, 3' x 7'	Baghouse hopper enclosure
		Door (Incl. Frame & Hardware)	
	24.17.00	**Elevator**	
		Elevator	Modify Existing Elevator
		Elevator	
	24.27.15	**Masonry, Block, Concrete**	
		Masonry, Block, Concrete-10 inch hollow reinforced	ACI / DSI elect/mech buildings
		Masonry, Block, Concrete	
	24.33.00	**Plumbing Fixture**	
		Shower / Eyewash	Baghouse EE bld battery area
		Shower / Eyewash	ACI/DSI silos
		Plumbing Fixture	
	24.35.00	**Pre-engineered Building (Prefabricated)**	
		PDC building only, equipment separate, incl h&v, lighting	PDC's for unit substations 480 V switchgear, BH2A, BH2B
		Engineered buildings, incl h&v, lighting	1 ea - ACI, 1 ea - DSI elect/mech blds, Bld will house U3 & U4 blowers. U4 blowers installed as part of separate estimate.
		Pre-engineered Building (Prefabricated)	
	24.37.00	**Roofing**	
		Steel roof panel - standing seam 22 ga, 2.5" thk fiberglass insulation	Electrical equipment enclosure
		Steel roof panel - standing seam 22 ga, 2.5" thk fiberglass insulation	Air compressor enclosure
		Steel roof panel - standing seam 22 ga, 2.5" thk fiberglass insulation	Baghouse penthouse
		Gutter, box, aluminum	Electrical equipment enclosure
		Downspout, round, aluminum	Electrical equipment enclosure
		Gutter, box, aluminum	Air compressor enclosure
		Downspout, round, aluminum	Air compressor enclosure
		Gutter, box, aluminum	Baghouse penthouse
		Downspout, round, aluminum	Baghouse penthouse
		Steel roof panel - standing seam 22 ga, 2.5" thk fiberglass insulation	Inlet - outlet duct
		Roofing	
	24.41.00	**Siding**	
		Steel siding - sandwich panel 22ga, galv, 2" insulation	Electrical equipment enclosure

Group	Phase	Description		Notes
		Steel siding - sandwich panel 22ga, galv, 2" insulation		Air compressor enclosure
		Steel siding - sandwich panel 22ga, galv, 2" insulation		Baghouse/penthouse walls
		Steel siding - sandwich panel 22ga, galv, 2" insulation		Baghouse hopper enclosure walls
		Steel siding - sandwich panel 22ga, galv, 2" insulation		Inlet-outlet duct
		Siding		
		ARCHITECTURAL		
27.00.00		**PAINTING & COATING**		
	27.13.00	**Coating**		
		1" Pipe - painting & surface prep		
		1.5" Pipe - painting & surface prep		
		2" Pipe - painting & surface prep		
		2.5" pipe - painting & surface prep		
		3" Pipe - painting & surface prep		
		6" Pipe - painting & surface prep		
		8" Pipe - painting & surface prep		
		Painted steel touch up & misc painting		
		Coating		
		PAINTING & COATING		
31.00.00		**MECHANICAL EQUIPMENT**		
	31.17.00	**Compressor & Accessories**		
		Air dryers & accessories - twin tower dessicant 900 scfm		For baghouse cleaning, ACI/DSI silo fluidization, and ash handling automatic valves, dampers and instrumentation
		Air receivers		For baghouse, ACI/DSI silo fluidization, and ash handling automatic valves, dampers and instrumentation - Cost included in air compressor
		Air compressors & accessories - 300 hp rotary screw oil free, air cooled 900 scfm / 125 psig		For baghouse, ACI/DSI silo fluidization, and ash handling automatic valves, dampers and instrumentation - Cost included in air compressor
		Compressor & Accessories		
	31.25.00	**Cranes & Hoists**		
		Electric hoist with trolley beam. 2.5 ton capacity, wire rope, 20 ft lifting height. provide 2 trolley beams for the one hoist		Air compressor building monorail hoist
		Cranes & Hoists		
	31.27.00	**Dampers & Accessories**		
		Dampers & Accessories		ID Fan louver dampers
		Dampers & Accessories	FGD	By pass duct damper
		Dampers & Accessories	Stack	By pass duct damper,
		Dampers & Accessories		
	31.27.15	**Dampers & Accessories, Damper Drive Units (Incl Linkage)**		
		Dampers & Accessories, Damper Drive Units		Baghouse bypass duct damper. Provided and installed by baghouse vendor.
		Dampers & Accessories, Damper Drive Units		Stack bypass damper drive, electronic drive type.
		Dampers & Accessories, Damper Drive Units (Incl Linkage)		
	31.33.00	**Expansion Joint**		
		Expansion joint		Baghouse to ID fan
		Expansion joint		Air heater to baghouse
		Expansion Joint		
	31.35.45	**Fans & Accessories (Excl HVAC), Radial Flow (Centrifugal)**		
		Fans & Accessories (Excl HVAC), Radial Flow (Centrifugal)		Replacement ID fans at current location
		Fans & Accessories (Excl HVAC), Radial Flow (Centrifugal)		
	31.41.00	**Fire Protection Equipment & System**		
		Fire protection / detection system, including dry pipe type, signals & controls		For baghouse, ACI, DSI areas, Furnish install subcontract cost, allowance
		Fire protection / detection system, including dry pipe type, signals & controls		For Transformer areas, Furnish install subcontract cost, allowance
		Fire Protection Equipment & System		
	31.45.00	**Flue Gas Cleanup, FGD Equipment**		
		Flue Gas Cleanup, WFGD		WFGD reliability upgrades - allowance
		Flue Gas Cleanup, FGD Equipment		
	31.51.00	**Flue Gas Cleanup, Mercury Removal Equipment**		
		Activated Carbon Injection (ACI)		ACI Equipment (1 silo, 2 hoppers-2 feeders-3 blowers)
		Flue Gas Cleanup, Mercury Removal Equipment		
	31.55.55	**Flue Gas Cleanup, SO3 Mitigation Equipment, Trona System**		

Group	Phase	Description	Notes
		Dry Sorbent Injection system (DSI)	Dry Sorbent Injection system, DSI (1 silo, 2 hoppers-2 feeders-3 blowers)
		DSI crushing and milling system	
		Flue Gas Cleanup, SO3 Mitigation Equipment, Trona System	
	31.57.00	Flue Gas Cleanup, Particulate Removal Equipment	
		Adder for upgrading to zero leak dampers incl seal air system	Included with the baghouse price
		Pulse Jet Baghouses with 1casings @ A/C=3.6fpm, incl precoat material, initial fill of ptfe woven fiberglass bags and cages, support steel, penthouse	Unit 2 Baghouse built on struct steel platform, above existing U1 precipitator and water tanks. (Tanks to be relocated).
		Pulse Jet Baghouses with 1casings @ A/C=3.6fpm	Unit 2 Baghouse built on elevated struct steel. Added premium for working up on high platform.
		Flue Gas Cleanup, Particulate Removal Equipment	
		MECHANICAL EQUIPMENT	
33.00.00		MATERIAL HANDLING EQUIPMENT	
	33.13.00	Ash Handling Equipment	
		Ash Handling Equipment	
		MATERIAL HANDLING EQUIPMENT	
34.00.00		HVAC	
	34.33.00	HVAC, Ductwork	
		Louver, movable blade w/actuator	Baghouse compressor room
		Louver, movable blade w/actuator	Baghouse penthouse and hopper enclosure
		Louver, movable blade, w/actuator	ACI/DSI blower/electrical building
		Ductwork	Air compressor inlet/outlet duct, baghouse compressor room
		Ductwork including fire dampers, relief dampers, registers	Baghouse EE enclosure (BEEE)
		HVAC, Ductwork	
	34.41.00	HVAC, Fan	
		Belt drive wall mounted exhaust fan,	Baghouse penthouse and hopper enclosure
		Belt drive wall mounted exhaust fan	Baghouse compressor room
		Belt drive wall mounted exhaust fan	ACI/DSI blower/electrical building
		HVAC, Fan	
	34.45.00	HVAC, Heating & Cooling Units	
		Wall mounted hvac units with integral heaters and filtration, 3 ton	ACI/DSI blower/electrical building
		Air handling hvac units with integral heaters and filtration	Baghouse EE enclosure (BEEE)
		HVAC, Heating & Cooling Units	
	34.53.00	Unit Heater	
		Baghouse penthouse and hopper enclosure	
		Baghouse compressor room	
		ACI/DSI blower/electrical building	
		Unit Heater	
		HVAC	
35.00.00		PIPING	
	35.13.00	STAINLESS STEEL PIPING	
		Instrument tubing	
		Misc instrument piping	
		Lube oil supply (motor)	
		BH compressor / air dryer / receiver interconnect piping	
		Misc instrument piping	
		Lube oil supply (fan)	
		Lube oil supply (header)	
		Extend compressed air header to new aci blower / electrical building	
		BHcompressor / air dryer / receiver interconnect piping	
		Cross tie with existing boiler building instrument air system	
		BH compressor / air dryer / receiver interconnect piping	
		ACI/DSI silo area	
		Demin supply & return,from new tank location.	
		Ash handling system - instrument air	
		STAINLESS STEEL PIPING	
	35.14.00	COPPER	
		Potable water riser to new baghouse ee building battery room eyewash stations	
		ACI/DSI silo area eyewash stations	
		COPPER	
	35.15.00	CARBON STEEL	

Group	Phase	Description	Notes
		FF hose station drop piping	
		Lube oil return (motor)	
		Misc drainage piping (eyewashes)	
		Piping to ff hose stations	
		Lube oil return (fan)	
		Lube oil return (header)	
		Service water piping from grade up to baghouse	
		FF floor drain lines, below ground	
		FF floor drains combined line to existing plant drains system, below ground	
		Filtered water replacement	
		Service water to DSI pin mixers	
		ACI	
		DSI	
		Service water to DSI mills.	
		Service water supply and returnfrom new tank location. (Buried).	
		Ash handling system - high pressure water supply to hydrovactor	
		CARBON STEEL	
	35.23.00	**IRON**	
		Potable water header to baghouse riser, below ground	
		Below ground	
		IRON	
	35.33.00	**PIPE SUPPORT HARDWARE**	
		1/2 in pipe support - single rod	
		3/4 in pipe support - single rod	
		1 in dia. pipe support - single rod	
		1.5 in dia. pipe support - single rod	
		2 in dia. pipe support - single rod	
		2.5 in dia. pipe support - single rod	
		3 in dia. pipe support - single rod	
		4 in dia. pipe support - single rod	
		6 in dia. pipe support - single rod	
		8 in dia. pipe support - single rod	
		PIPE SUPPORT HARDWARE	
	35.41.00	**VALVES**	
		Valves, IA, service water, pot. water	
		Pressure Regulators	Water and Air
		VALVES	
	35.99.00	**Piping, User Defined**	
		Lube oil supply (motor)	
		Lube oil supply (fan)	
		Lube oil return (motor)	
		Lube oil return (fan)	
		BOP Specialties	
		Piping, User Defined	
		PIPING	
36.00.00		**INSULATION**	
	36.13.00	**Insulation, Duct**	
		Mineral wool insulation 4" thk, 8 lb/cf density, aluminum lagging - installed in place	Baghouse inlet and outlet
		Mineral wool insulation 4" thk, 8 lb/cf density, aluminum lagging - installed in place	Replacement duct booster to ID fan
		Mineral wool insulation 4" thk, 8 lb/cf density, aluminum lagging - installed in place	Baghouse casing
		Mineral wool insulation 6" thk, 8 lb/cf density, aluminum lagging - installed in place	Baghouse hoppers
		Mineral wool insulation & lagging incl removable panels - installed in place	New booster Fans (QTY 2)
		Mineral wool insulation & lagging	Replace insulation removed for fan reinforcement
		Insulation, Duct	
	36.15.00	**Insulation, Equipment**	
		Extend compressed air header to new ACI/DSI blower/electrical building	
		Cross tie with existing boiler building instrument air system	

Group	Phase	Description	Notes
		Potable water riser to new baghouse ee building battery room eyewash stations	
		Service water piping from grade up to baghouse	
		ACI/DSI silo area eyewash stations.	
		Service water to DSI mills.	
		Insulation, Equipment	
		INSULATION	
41.00.00		**ELECTRICAL EQUIPMENT**	
	41.13.00	**Bus Duct**	
		Cable bus 2000A	
		Isolated phase bus duct modifications	At UAT-2B HV Terminations, GAT-2B HV Terminations
		Bus Duct	
	41.15.00	**Cathodic Protection**	
		Cathodic protection system	
		Cathodic Protection	
	41.17.00	**Communication System**	
		Communication system	
		Communication System	
	41.21.00	**Control & Backup Power**	
		UPS testing & adjustments	
		UPS- 30kva, 15kva bypass transformer, 150a, 120vac panel	
		125vdc 1600ah lead calcium battery w/rack, 2-150amp chargers, 200a dc distribution panel	
		Control & Backup Power	
	41.23.00	**Motors**	
		Test	Test & debug and documentations
		7000HP ID Booster fan motors	6600V reduced voltage, solid state start, including couplings
		Motors	
	41.31.00	**Electrical Equipment,Grounding**	
		Bare copper wire, 500 kcmil	Underground for station ground grid
		Bare copper wire, 4/0	Equipment grounding connection
		Exothermic weld	Bare copper wire, 4/0
		Insulated ground copper wire, 4/0	DCS ground cable from copper bar in bh bldg to station ground grid
		Rod, copper clad 20' long, 3/4" dia	
		Brazed Connection	Bare copper wire, 500 kcmil
		Equipment Grounding	
		Electrical Equipment,Grounding	
	41.33.00	**Heat Tracing**	
		Heat trace transformers, 480-120/208v 3 phase, 45 kva, square d, cutler hammer	
		Heat trace power and monitor panels, each with twelve 30a breakers and eight-15a breakers, square d, cutler hammer	
		1.5" pipe heat tracing cable	
		2" pipe heat tracing cable	
		4" pipe heat tracing cable	
		Obrien enclosures	
		Vendor field assistance	
		Heat tracing engineering	
		Heat Tracing	
	41.35.00	**Lightning Protection**	
		Lightning protection	ACI silo, Baghouse, DSI silo
		Lightning Protection	
	41.37.00	**Lighting Accessory (Fixture)**	
		Exterior hid fixtures, wall mounted 150 watt	
		Interior fluorescent fixtures, 2'w x 4'l, two 40 watt	
		Lighting support (light fixtures)	
		Lighting Accessory (Fixture)	
	41.45.00	**Motor Control Center (MCC), Complete**	
		MCCs testing & calibrations	Test & debug and documentations
		480V motor control center, 600a,nema12	ACI MCCs
		480V motor control center, 600a, nema12	DSI MCCs
		480V motor control center, 1200a, nema12	Baghouse MCCs
		Motor Control Center (MCC), Complete	
	41.47.00	**Panel: Control, Distribution, & Relay**	

Group	Phase	Description	Notes
		Modify relay panel for exist SWGR-2B	
		lighting panels, 277/480v three phase, 42 circuits, square d or cutler hammer	
		lighting panels, 120/208v three phase, 30 circuits, square d or cutler hammer	
		480 vac power panels, 100a, 24 circuit, square d or cutler hammer (indoor)	
		480 vac power panels, 600a, 24 circuit, square d or cutler hammer (indoor)	
		Panel: Control, Distribution, & Relay	
	41.51.00	**Power Transformer**	
		Test	New UAT
		75KVA, 480-480/277V, 3 PHASE	Lighting transformers
		30KVA, 480-480/277V, 3 PHASE	Lighting transformers
		15KVA, 480-120/208V, 3 PHASE	Lighting transformers
		Isolation transformer, 480-120/208 vac, 1-phase, 25 kva, wall mounted (indoor rated)	
		2000/2666KVA, 6.9KV-480V Unit Substation Transformers (dry ventilated/indoor)	No housekeeping pad req'd
		27/36 MVA, 2 winding 22.8 - 6.9KV (oil filled outdoor)	Replace existing UAT-2B, and GAT-2
		Power Transformer	
	41.55.00	**Switchgear, Complete**	
		Switchgear testing & calibrations	Test & debug and documentations
		480V Switchgear, 3200A, 5 vertical sections, 2-3200A MAIN BRKRS, 1-3200A TIE BRKR	Indoor rated load center
		6.9KV Switchgear, 2000A, 500MVA, ARC RESISTANT, 4 VERTICAL SECTIONS, 1 - 2000A MAIN BRKR, 1 - 2000A RESERVE BRKR, 3 - 1200A FDR BRKR,	New PDC incl building and equipment, SWGR-2C,
		Switchgear, Complete	
	41.55.27	**Switchgear, Complete, 6.9 KV**	
		Modify controls in existing SWGR - 2B, to interface with new SWGR - 2C.	EXISTING SWGR-2B
		Switchgear, Complete, 6.9 KV	
	41.57.00	**Wiring Device**	
		480 VAC Welding Receptacles (60 AMP), OZ GEDNEY WSR6352 WITH APJ PLUG, outdoor rated	
		480 VAC Power outlets (60 AMP), OZ GEDNEY AREA6585 outdoor rated	
		120 VAC Convenience outlets	
		Wiring Device	
		ELECTRICAL EQUIPMENT	
42.00.00		**RACEWAY, CABLE TRAY & CONDUIT**	
	42.13.00	**Cable Tray**	
		18" wide alum. ladder cable tray	
		18" wide alum. cable tray cover	
		24" wide alum. ladder cable tray	
		18" wide solid bottom galv. steel cable tray	
		24" wide solid bottom galv. steel cable tray	
		36" wide alum. ladder cable tray	
		18" wide galv. steel cable tray cover	
		24" wide galv. steel cable tray cover	
		Cable Tray	
	42.15.00	**Conduit**	
		RGS conduit	
		sealtite flex conduit	
		Conduit	
	42.17.00	**Conduit Box**	
		Local junction boxes with 2-12 point terminal blocks, nema 4x fiberglass	
		Local junction boxes with 8-12 point terminal blocks, nema 4x fiberglass	
		Pull boxes, nema 4x fiberglass	
		Conduit Box	
	42.99.00	**Raceway, Cable Tray, & Conduit, User Defined**	
		Concrete duct bank (BEEE to ACI EE/MEB)	
		Concrete duct bank (DSI EE/MEB TO DSI SILO)	

Group	Phase	Description		Notes
		Concrete duct bank (BEEE TO DSI EE/MEB)		
		Concrete duct bank (ACI EE/MEB TO ACI SILO)		
		Concrete duct bank (Ash vacuum exhausters to nearby tray)		
		Underground Survey		
		Concrete duct bank (GAT-2 to SWGR-2C)		
		Manhole 6' x 4' x 8' GAT-2 to SWGR-2C, SWOF existing oily water sump.		
		Raceway, Cable Tray, & Conduit, User Defined		
		RACEWAY, CABLE TRAY & CONDUIT		
43.00.00		**CABLE**		
	43.13.00	**Control & Instrument Cable**		
		FIBER OPTIC (6 FIBER 12/C)		
		FIBER OPTIC (12 FIBER 12/C)		
		2/C #10 AWG 600V		
		4/C #10 AWG 600V		
		2/C #14 AWG 600V		
		1 PR #16 AWG TSP		
		2 PR #16 AWG TSP		
		4 PR #16 AWG TSP		
		4 PR #23 CAT-6 (Ethernet 5e)		
		5/C #14 AWG 600V		
		7/C #14 AWG 600V		
		9/C #14 AWG 600V		
		12/C #14 AWG 600V		
		19/C #14 AWG 600V		
		#10 AWG TERMINATIONS	Wire tag & documentation	
		#14 AWG TERMINATIONS	Wire tag & documentation	
		#16 THERMOCOUPLE WIRE TERMINATIONS	Wire tag & documentation	
		FIBER OPTIC TERMINATIONS	Wire tag & documentation	
		CAT-6 ETHERNET CABLE TERMINATION (RJ45)	Wire tag & documentation	
		Control & Instrument Cable		
	43.17.25	**Medium Voltage Power Cable, 8 KV**		
		Medium Voltage Power Cable, 8 KV	1/C #500 KCML	
		Medium Voltage Power Cable, 8 KV	1/C #750 KCML	
		#500 KCML Terminations	Wire tag & documentation	
		#750 KCML Terminations	Wire tag & documentation	
		Medium Voltage Power Cable, 8 KV		
	43.21.15	**Low Voltage Power Cable, 600 V**		
		Low Voltage Power Cable, 600 V 1 /c # 750 kcmil		
		Low Voltage Power Cable, 600 V 1 /c # 500 kcmil		
		Low Voltage Power Cable, 600 V 1 /c # 350 kcmil		
		Low Voltage Power Cable, 600 V 1 /c # 12 awg	For lighting	
		Low Voltage Power Cable, 600 V 3 /c # 4/0 awg		
		Low Voltage Power Cable, 600 V 3 /c # 2/0 awg		
		Low Voltage Power Cable, 600 V 3 /c # 1/0 awg		
		Low Voltage Power Cable, 600 V 4 /c # 1/0 awg		
		Low Voltage Power Cable, 600 V 3 /c # 2 awg		
		Low Voltage Power Cable, 600 V 3 /c # 4 awg		
		Low Voltage Power Cable, 600 V 3 /c # 6 awg		
		Low Voltage Power Cable, 600 V 3 /c # 10 awg		
		Low Voltage Power Cable, 600 V 4 /c # 4/0 awg		
		Low Voltage Power Cable, 600 V 4 /c # 2 awg		
		Low Voltage Power Cable, 600 V		
	43.21.35	**Low Voltage Power Cable, Termination**		
		Low Voltage Power Cable, #750 kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #500 kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #350 kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #4/0 AWG kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #2/0 AWG kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #1/0 AWG kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #2 AWG kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #4 AWG kcml Termination	Wire tag & documentation	
		Low Voltage Power Cable, #6 AWG kcml Termination	Wire tag & documentation	

Group	Phase	Description	Notes
		Low Voltage Power Cable, #12 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #10 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, Termination	
	43.21.99	**Low Voltage Power Cable & Termination**	
		Low Voltage Power Cable & Termination, Testing	Wire testing & documentation
		Low Voltage Power Cable & Termination	
		CABLE	
44.00.00		**CONTROL & INSTRUMENTATION**	
	44.13.00	**Control System**	
		I/O Loop testing - Field verification	Baghouse, ACI, DSI SYSTEM
		DCS cabinet installation	Baghouse, ACI, DSI SYSTEM
		I/O Loop testing - Field verification	AH.AP, FIRE. DET., INST. AIR
		DCS cabinet installation (panel cost by others)	AH.AP, FIRE. DET., INST. AIR
		Cabinets, I/O point programming, labeling, documentation	AH.AP, FIRE. DET., INST. AIR
		Cabinets, I/O point programming, labeling, documentation	Baghouse, ACI, DSI SYSTEM
		Control System	
	44.21.00	**Instrument**	
		Test & Startup	Test & debug and documentations
		Implosion protection-trip redundant pressure transmitters	
		Proven air flow on ID Booster fans	
		Local devices not wired by baghouse contractor	
		Monitoring Equipment	ID Booster fan vibration
		Instrument	
	44.25.27	**Continuous Emission Monitoring System (CEMS)**	
		Continuous Emission Monitoring System (CEMS)	PM CEMS
		Continuous Emission Monitoring System (CEMS)	Hg CEMS
		Continuous Emission Monitoring System (CEMS)	HCL CEMS
		Continuous Emission Monitoring System Shelter	
		Continuous Emission Monitoring System (CEMS)	
		CONTROL & INSTRUMENTATION	
61.00.00		**CONSTRUCTION INDIRECT - Major Equip.**	
	61.13.00	**Construction Indirect, Construction Equipment**	
		Construction Indirect, Construction Equipment	Crane, Manitowoc 18000, 6 Months. Incl. Mob & Demob and Operator
		Construction Indirect, Construction Equipment, incl mob / demob, & operators	Tower crane; 1 Crane, 6 Months. Incl. Mob & Demob and Operator
		Construction Indirect, Construction Equipment	
		CONSTRUCTION INDIRECT - Major Equip.	
71.00.00		**PROJECT INDIRECT - Conditions Assesments**	
	71.99.00	**Project Indirect, User Defined**	
		Flue gas train transient pressure analysis	
		ESP/SCR OEM Engineering assesment for revised draft/transient	
		Project Indirect, User Defined	
		PROJECT INDIRECT - Conditions Assesments	
91.00.00		**CONSTRUCTION INDIRECTS**	
93.00.00		**PROJECT INDIRECTS**	
94.00.00		**CONTIGENCY**	
96.00.00		**ESCALLATION**	

Estimate No: 31687A
Project No: 10572-069
Issue Date 06/20/12

Indianapolis Power and Light Company
Petersburg Unit 3 Baghouse, ACI-DSI
Conceptual Cost Estimate

Sargent & Lundy, LLC

Group	Description	Total Amount
11.00.00	DEMOLITION	$2,198,989
21.00.00	CIVIL WORK	$2,610,942
22.00.00	CONCRETE	$2,457,978
23.00.00	STEEL	$27,317,206
24.00.00	ARCHITECTURAL	$1,550,424
27.00.00	PAINTING & COATING	$287,859
31.00.00	MECHANICAL EQUIPMENT	$35,108,627
33.00.00	MATERIAL HANDLING EQUIPMENT	$2,461,907
34.00.00	HVAC	$826,420
35.00.00	PIPING	$2,332,343
36.00.00	INSULATION	$3,632,637
41.00.00	ELECTRICAL EQUIPMENT	$8,097,697
42.00.00	RACEWAY, CABLE TRAY & CONDUIT	$2,843,260
43.00.00	CABLE	$2,824,562
44.00.00	CONTROL & INSTRUMENTATION	$3,032,079
61.00.00	CONSTRUCTION INDIRECT MAJOR EQUIPMENT	$3,000,000
71.00.00	PROJECT INDIRECT - EXISTING EQUPMENT ASSESSMENT	$500,000
91.00.00	CONSTRUCTION INDIRECTS	$27,638,500
93.00.00	PROJECT INDIRECTS	$14,159,300
94.00.00	CONTIGENCY	$19,436,100
96.00.00	ESCALLATION	$8,322,200
98.00.00	INTREST DURING CONSTRUCTION (AFUDC)	$0
	TOTAL PROJECT COSTS	$170,639,030

Estimate No: 31687
Project No: 3004-000
Issue Date: 06/20/12

Indianapolis Power and LIght Company
Petersburg, Unit 3 Baghouse, ACI-DSI
Conceptual Cost Estimate

Sargent & Lundy, LLC.

Group	Phase	Description	Notes
11.00.00		**DEMOLITION**	
	11.21.00	**Demolition, Civil Work**	
		Disposal	Disposal - rubbish from demolition
		Demolition, Civil Work	
	11.23.00	**Demolition, Steel**	
		Steel	North of Unit 1 stack
		Ductwork	Between ID and booster fans trains A&B
		Ductwork, demo insulation and openings into existing ductwork	Tie in points of new ductwork to existing ductwork
		Demolition, Steel	
	11.27.00	**Demolition, Painting & Coating**	
		Painting & Coating	Piping and structural steel lead paint abatement allowance
		Demolition, Painting & Coating	
	11.31.00	**Demolition, Mechanical Equipment**	
		Demolition, Mechanical Equipment	Demo booster fans and lube oil skids
		Demolition, Mechanical Equipment	Unit 2 ESP area, aboveground mechanical / piping demo/relocation - Allowance
		Demolition, Mechanical Equipment	Unit 2 ESP area, underground mechanical demo/relocation incl piping - Allowance
		Demolition, Mechanical Equipment	
	11.41.00	**Demolition, Electrical Equipment**	
		Remove existing transformer 132kv-4.16kv, cables and fire protection piping	
		Remove existing transformer 20.9kv-4.16kv, iso phase bus, cables and fire protection piping	
		Remove (2) Existing 4500HP/4KV ID Booster Fan Motors	
		Demolition, Electrical Equipment	
	11.42.00	**Demolition, Raceway, Cable Tray, & Conduit**	
		3" RGSConduit	
		3" Sealtite flex conduit, 3 ft long	
		Demolition, Raceway, Cable Tray, & Conduit	
	11.43.00	**Demolition, Cable**	
		Cables / power feeds	2 booster fans lube oil & blower skids
		3/C #4/0 AWG 600V	Ash handling vacuum exhausters
		3/C #10 AWG 600V	Ash handling vacuum exhausters
		7/C #12 AWG 600V	Ash handling vacuum exhausters
		1 PR #16 AWG TSP	Ash handling vacuum exhausters
		Demolition, Cable	
		DEMOLITION	
21.00.00		**CIVIL WORK**	
	21.13.45	**Strip & Stockpile Topsoil**	
		Strip & Stockpile Topsoill -300 ft haul	Riverbank for ACI & DSI silos
		Strip & Stockpile Topsoil	
	21.17.15	**Earthwork, Excavation & Backfill, Foundation**	
		Earthwork, Excavation	Transformer pad
		Earthwork, Excavation	Booster fan mods train A&B
		Earthwork, Excavation	ACI elect/mech bld foundation,
		Earthwork, Excavation	Baghouse foundation extension
		Earthwork, Excavation	Duct support foundation
		Earthwork, Excavation	Fly ash transfer station,
		Earthwork, Excavation	Switchgear bld,
		Earthwork, Excavation	Misc equipment supports
		Earthwork, Excavation & Backfill, Foundation	
	21.19.15	**Earthwork, Disposal of Excess Material**	
		Earthwork, Disposal of Excess Material	Transformer pad
		Earthwork, Disposal of Excess Material	Booster fan mods
		Earthwork, Disposal of Excess Material	ACI elect/mech bld foundation
		Earthwork, Disposal of Excess Material	Baghouse foundations, extension
		Earthwork, Disposal of Excess Material	Duct support foundation
		Earthwork, Disposal of Excess Material	Fly ash transfer station
		Earthwork, Disposal of Excess Material	Switchgear bld,
		Earthwork, Disposal of Excess Material	
	21.23.00	**Earthwork, Backfill**	
		Earthwork, Backfill - select structural fill	Backfill riverbank for ACI & DSI silos
		Earthwork, Backfill	Transformer pad

Group	Phase	Description	Notes
		Earthwork, Backfill	Booster fan mods train A&B
		Earthwork, Backfill	ACI elect/mech bld foundation,
		Earthwork, Backfill	Baghouse foundation extension
		Earthwork, Backfill	Duct support foundation
		Earthwork, Backfill	Fly ash transfer station
		Earthwork, Backfill	Switchgear bld,
		Earthwork, Backfill	Misc equipment supports
		Earthwork, Backfill	
	21.43.00	**Fencework**	
		Fencework - Security Fence, 10 ft tall, posts set in concrete	
		Fencework - Vehicle Gate - 14 ft wide x 7 ft tall	
		Fencework	
	21.53.00	**Piling & Caisson**	
		Augercast Pile 24" dia. X 50'	Baghouse foundation extension
		Sheet piling, 27 psf, incl walers and bracing	For ACI and DSI area
		Micro Pile 10" dia. X 50'	ID fan modification, train A
		Micro Pile 10" dia. X 50'	ID fan modification, train B
		Micro Pile 10" dia. X 50'	Duct support foundations
		Augercast Pile 16" dia. X 50'	ACI elect/mech bld foundation,
		Pile load test	Cost included in Unit 2 estimate
		Mobilization / demobilization	
		Piling & Caisson	
	21.57.00	**Road, Parking Area, & Surfaced Area**	
		Gravel road, 16 ft wide 4" thk	
		4" gravel surfacing	Construction laydown
		Road, Parking Area, & Surfaced Area	
	21.67.00	**Survey**	
		SURVEY	
		Survey	
	21.68.00		
		GEOPHYSICAL INVESTIGATION	
		21.68.00	
		CIVIL WORK	
22.00.00		**CONCRETE**	
	22.13.00	**Concrete**	
		Concrete	Transformer pad
		Concrete	ACI elect/mech bld foundation,
		Concrete	Baghouse foundations, extension
		Concrete	Duct support foundation
		Concrete	Booster fan mods
		Concrete	Misc Equipment Supports
		Concrete	Concrete fill between steel framework at baghouse base
		Concrete	Fly ash transfer station
		Concrete	Switchgear bld
		Concrete mud mat	General stagging
		Concrete	For widening main access road
		Concrete	
	22.15.00	**Embedment**	
		Embedment	Transformer pad
		Embedment	ACI elect/mech bld foundation
		Embedment	Baghouse foundations, extension
		Embedment	Duct support foundation
		Embedment	Booster fan mods
		Embedment	Misc Equipment Supports
		Embedment	Fly ash transfer station
		Embedment	Switchgear bld
		Embedment, dowel into existing concrete	For widening main access road
		Embedment	
	22.17.00	**Formwork**	
		Formwork	Transformer pad
		Formwork	ACI elect/mech bld foundation,
		Formwork	Baghouse foundations, extension
		Formwork	Duct support foundation

Group	Phase	Description	Notes
		Formwork	Booster fan mods
		Formwork	Misc Equipment Supports
		Formwork	Fly ash transfer station
		Formwork	Switchgear bld,
		Formwork	For widening main access road
		Formwork	
	22.21.00	**Concrete, Miscellaneous**	
		No. 8 dowel, 1 in dia x 54 in long	Existing booster fan pedestal, A&B train
		Concrete impact drilling, 1" dia x 27" embedment	Existing booster fan pedestal, A&B train
		Epoxy grout dowels, 1" dia x 27"	Existing booster fan pedestal, A&B train
		No. 10 dowel, 1.25 in dia x 70 in long	Existing booster fan foundation, A&B train
		Concrete impact drilling, 1.25" dia x 35" embedment	Existing booster fan foundation, A&B train
		Epoxy grout dowels, 1.25" dia x 35"	Existing booster fan foundation, A&B train
		Scarify concrete surface	Existing booster fan foundation, A&B train
		Concrete epoxy bonding agent	Existing booster fan foundation, A&B train
		No. 10 dowel, 1.75 in dia x 70 in long	Baghouse foundations, extension
		Concrete impact drilling, 1.75" dia x 35" embedment	Baghouse foundations, extension
		Epoxy grout dowels, 1.75" dia x 35"	Baghouse foundations, extension
		Scarify concrete surface	Baghouse foundations, extension
		Concrete epoxy bonding agent	Baghouse foundations, extension
		Concrete, Miscellaneous	
	22.25.00	**Reinforcing**	
		Reinforcing	Transformer pad
		Reinforcing	ACI elect/mech bld foundation, 2 ACI silos, 2 DSI silos
		Reinforcing	Baghouse foundations, extension
		Reinforcing	Duct support foundation
		Reinforcing	Booster fan mods
		Reinforcing	Misc Equipment Supports
		Reinforcing	Fly ash transfer station
		Reinforcing	Switchgear bld
		Reinforcing	For widening main access road
		Reinforcing	
		CONCRETE	
23.00.00		**STEEL**	
	23.15.00	**Ductwork**	
		Mandoor for ductwork	Baghouse inlet
		Mandoor for ductwork	Baghouse outlet
		Sliding plate bearing assembly	Baghouse inlet
		Sliding plate bearing assembly	Baghouse outlet
		Existing ductwork modifications	Baghouse outlet & inlet
		Ductwork - Panel construction	Baghouse outlet & inlet
		Ductwork turning vanes	Baghouse to ID fan, in existing duct at ID fan inlet
		Ductwork - Panel construction	Between fans A&B train
		Ductwork stiffeners	Ductwork stiffeners upstream of new ducts
		Ductwork	
	23.17.00	**Gallery**	
		Swing gates	Duct support steel
		Handrail with guardplate	Duct support steel
		Grating	Fan area
		Ladders with safety cages	Duct support steel
		Stairs and pipe railing, # of treads	Duct support steel
		Grating	Duct access
		Grating	Baghouse Area
		Gallery	
	23.25.00	**Rolled Shape**	
		Structural Steel	Framing for baghouse penthouse and hopper enclosure supplied by baghouse supplier
		Channel girts & sag rods	Baghouse penthouse and hopper enclosure
		Channel girts & sag rods	Electrical equipment enclosure
		Channel girts & sag rods	Air compressor enclosure
		Structural Steel	Misc Equipment Supports
		Structural Steel	Misc access galleries
		Structural Steel	Duct support steel

Group	Phase	Description	Notes
		Structural Steel	Baghouse framework
		Structural Steel	ID Fan casing reinforcement for new operating and transient pressures, allowance subcontract cost
		Structural Steel	Reinforcement of ESP, SCR and ductwork from AH outlet to ID fan inlet not included
		Structural Steel	Reinforce existing steel framing around unit 3 baghouse
		Structural Steel	Duct support modification steel
		Structural Steel	Cable tray, southwest to unit 3 fans
		Structural Steel	ACI & DSI piperack
		Structural Steel	Access galleries for ACI & DSI
		Structural Steel	Access galleries for ID fan & booster fan
		Rolled Shape	
		STEEL	
24.00.00		**ARCHITECTURAL**	
	24.15.00	**Door (Incl. Frame & Hardware)**	
		Insulated double door & frame, 6' x 7'	Baghouse hopper enclosure
		Insulated door & frame, 3' x 7'	Electrical equipment enclosure
		Insulated double door & frame, 6' x 7'	Electrical equipment enclosure
		Insulated door & frame, 3' x 7'	Air compressor enclosure
		Insulated double door & frame, 6' x 7'	Air compressor enclosure
		Insulated door & frame, 3' x 7'	Baghouse penthouse
		Insulated double door & frame, 6' x 7'	Baghouse penthouse
		Insulated door & frame, 3' x 7'	Baghouse hopper enclosure
		Door (Incl. Frame & Hardware)	
	24.27.15	**Masonry, Block, Concrete**	
		Masonry, Block, Concrete-10 inch hollow reinforced	ACI / DSI elect/mech buildings
		Masonry, Block, Concrete	
	24.33.00	**Plumbing Fixture**	
		Shower / Eyewash	ACI / DSI silos
		Shower / Eyewash	Baghouse
		Plumbing Fixture	
	24.35.00	**Pre-engineered Building (Prefabricated)**	
		PDC building only, equipment separate,incl h&v, lighting	PDC's for unit substations 480 V switchgear, BH3A, BH3B
		Engineered buildings, incl h&v, lighting	1 ea - ACI, 1 ea - DSI elect/mech blds, Bld will house U3 & U4 blowers. U4 blowers installed as part of separate estimate.
		Pre-engineered Building (Prefabricated)	
	24.37.00	**Roofing**	
		Steel roof panel - standing seam 22 ga, 2.5" thk fiberglass insulation	Electrical equipment enclosure
		Steel roof panel - standing seam 22 ga, 2.5" thk fiberglass insulation	Air compressor enclosure
		Steel roof panel - standing seam 22 ga, 2.5" thk fiberglass insulation	Baghouse penthouse
		Gutter, box, aluminum	Electrical equipment enclosure
		Downspout, round, aluminum	Electrical equipment enclosure
		Gutter, box, aluminum	Air compressor enclosure
		Downspout, round, aluminum	Air compressor enclosure
		Gutter, box, aluminum	Baghouse penthouse
		Downspout, round, aluminum	Baghouse penthouse
		Roofing	
	24.41.00	**Siding**	
		Steel siding - sandwich panel 22ga, galv, 2" insulation	Electrical equipment enclosure
		Steel siding - sandwich panel 22ga, galv, 2" insulation	Air compressor enclosure
		Steel siding - sandwich panel 22ga, galv, 2" insulation	Baghouse penthouse walls
		Steel siding - sandwich panel 22ga, galv, 2" insulation	Baghouse hopper enclosure walls
		Siding	
		ARCHITECTURAL	
27.00.00		**PAINTING & COATING**	
	27.13.00	**Coating**	
		1" Pipe - painting & surface prep	
		1.5" Pipe - painting & surface prep	
		2" Pipe - painting & surface prep	
		2.5" pipe - painting & surface prep	
		3" Pipe - painting & surface prep	
		6" Pipe - painting & surface prep	
		8" Pipe - painting & surface prep	
		Painted steel touch up & misc painting	

Group	Phase	Description	Notes
		Coating	
		PAINTING & COATING	
31.00.00		MECHANICAL EQUIPMENT	
	31.17.00	Compressor & Accessories	
		Air compressors & accessories - 300 hp rotary screw oil free, air cooled 900 scfm / 125 psig	For baghouse cleaning, ACI/DSI silo fluidization, and ash handling automatic valves, dampers and instrumentation
		Air dryers & accessories - twin tower dessicant 900 scfm	For baghouse, ACI/DSI silo fluidization, and ash handling automatic valves, dampers and instrumentation - Cost included in air compressor
		Air receivers	For baghouse, ACI/DSI silo fluidization, and ash handling automatic valves, dampers and instrumentation - Cost included in air compressor
		Compressor & Accessories	
	31.25.00	Cranes & Hoists	
		Electric hoist with trolley beam. 2.5 ton capacity, wire rope, 20 ft lifting height.	Compressor building monorail hoist
		Cranes & Hoists	
	31.27.00	Dampers & Accessories	
		Dampers & Accessories	ID Fan louver dampers
		Dampers & Accessories	FGD louver duct damper
		Dampers & Accessories	Booster fan inlet damper
		Dampers & Accessories	
	31.33.00	Expansion Joint	
		Expansion joint	ESP outlets to Baghouse
		Expansion joint	Baghouse outlet to ID fan tie points
		Expansion joint	Booster fans inlets / outlets
		Expansion Joint	
	31.35.45	Fans & Accessories (Excl HVAC), Radial Flow (Centrifugal)	
		7000 HP Centrifugal fan with lube oil skid	Replace existing 4000 HP fans with 7000 HP booster fans
		Fans & Accessories (Excl HVAC), Radial Flow (Centrifugal)	
	31.41.00	Fire Protection Equipment & System	
		Fire protection / detection system, including dry pipe type, signals & controls	For baghouse, ACI, DSI areas, Furnish install subcontract cost
		Fire protection / detection system, including dry pipe type, signals & controls	For Transformer areas, Furnish install subcontract cost
		Fire Protection Equipment & System	
	31.51.00	Flue Gas Cleanup, Mercury Removal Equipment	
		Activated Carbon Injection (ACI)	
		Flue Gas Cleanup, Mercury Removal Equipment	
	31.55.55	Flue Gas Cleanup, SO3 Mitigation Equipment, Trona System	
		Dry sorbent injection system (DSI)	
		DSI crushing & milling system	
		Flue Gas Cleanup, SO3 Mitigation Equipment, Trona System	
	31.57.00	Flue Gas Cleanup, Particulate Removal Equipment	
		Pulse Jet Baghouse with 1casing @ A/C=3.6fpm, incl precoat material, initial fill of ptfe woven fiberglass bags and cages, support steel, penthouse	
		Flue Gas Cleanup, Particulate Removal Equipment	
		MECHANICAL EQUIPMENT	
33.00.00		MATERIAL HANDLING EQUIPMENT	
	33.13.00	Ash Handling Equipment	
		Ash Handling Equipment	
		MATERIAL HANDLING EQUIPMENT	
34.00.00		HVAC	
	34.33.00	HVAC, Ductwork	
		Louver, movable blade,	Baghouse compressor room
		Louver, movable blade	Baghouse penthouse and hopper enclosure
		Louver, movable blade,	ACI / DSI blower / electrical bldg
		Ductwork	Air compressor inlet/outlet duct, baghouse compressor room
		Ductwork including fire dampers, relief dampers, registers	Baghouse EE enclosure (BEEE)
		HVAC, Ductwork	
	34.41.00	HVAC, Fan	
		Baghouse penthouse and hopper enclosure	
		Baghouse compressor room	

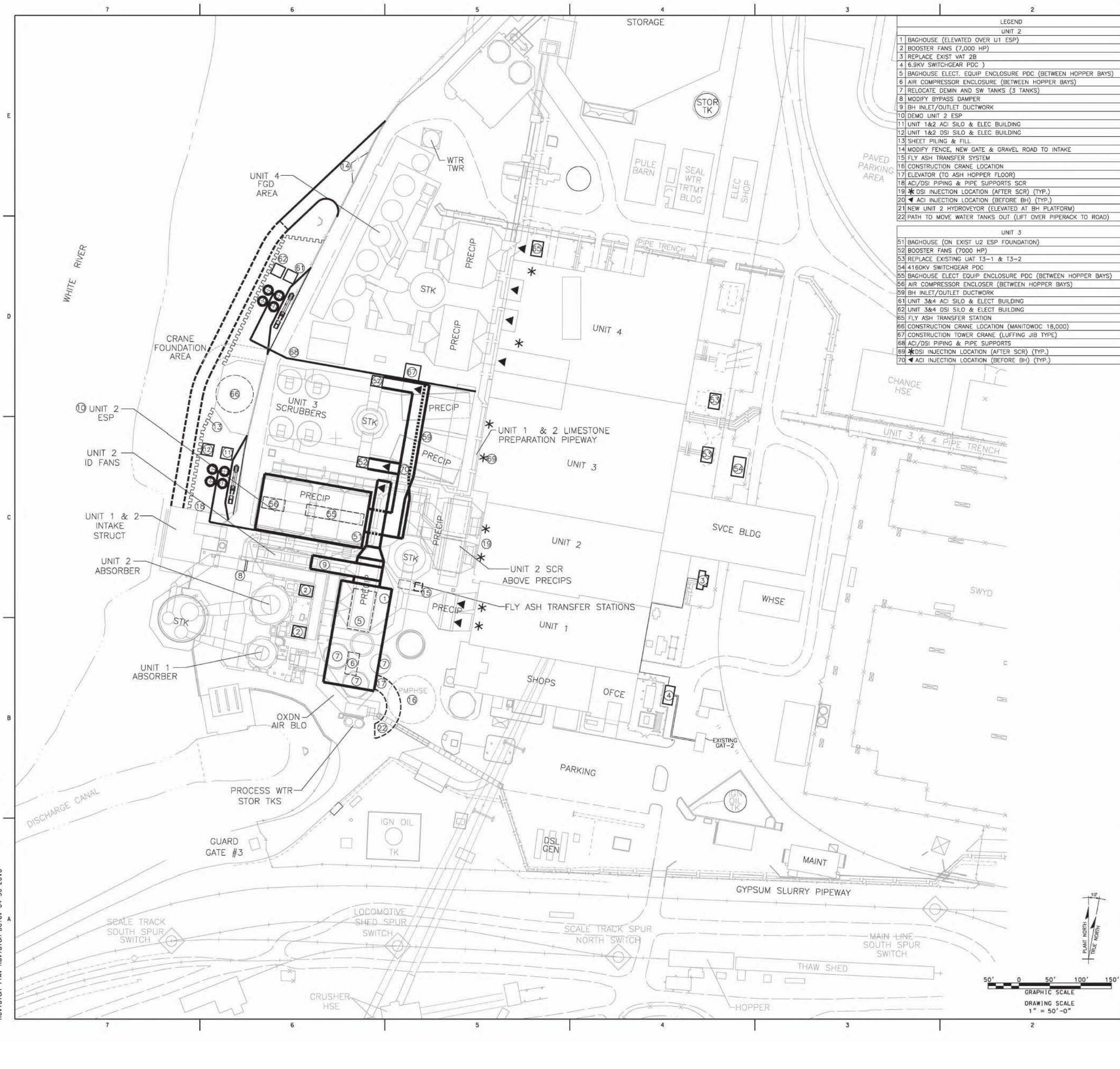
Group	Phase	Description	Notes
		ACI / DSI blower / electrical bldg	
		HVAC, Fan	
	34.45.00	**HVAC, Heating & Cooling Units**	
		ACI / DSI blower / electrical bldg	
		Baghouse EE enclosure (BEEE)	
		HVAC, Heating & Cooling Units	
	34.53.00	**Unit Heater**	
		Baghouse penthouse and hopper enclosure	
		Baghouse compressor room	
		ACI / DSI blower / electrical bldg	
		Unit Heater	
		HVAC	
35.00.00		**PIPING**	
	35.13.00	**STAINLESS STEEL BORE PIPING**	
		Instrument tubing	
		Misc instrument piping	
		Lube oil supply (motor)	
		BH compressor / air dryer / receiver interconnect piping	
		Misc instrument piping	
		Lube oil supply (fan)	
		Lube oil supply (header)	
		Extend compressed air header to new ACI / DSI blower / electrical building	
		BHcompressor / air dryer / receiver interconnect piping	
		Cross tie with existing boiler building instrument air system	
		BH compressor / air dryer / receiver interconnect piping	
		Instrument air to ACI / DSI blower building	
		Potable water piping to new eyewash stations in ACI / DSI areas	
		Ash handling - instrument air	
		STAINLESS STEEL BORE PIPING	
	35.15.00	**CARBON STEEL**	
		FF hose station drop piping	
		Lube oil return (motor)	
		Misc drainage piping (eyewashes)	
		Piping to ff hose stations	
		Lube oil return (fan)	
		Lube oil return (header)	
		Service water piping from grade up to baghouse	
		FF floor drain lines, below ground	
		FF floor drains combined line to existing plant drains system, below ground	
		Service water to ash silo pin mixer	
		Service water to DSI mills	
		ACI	
		DSI	
		Fire Protection	
		Ash handling - high pressure water to hydrovactor	
		CARBON STEEL	
	35.23.00	**IRON**	
		Install in baghouse area to replace existing pipe removed for unit 2 demolition	
		Below ground	
		IRON	
	35.33.00	**PIPE SUPPORT HARDWARE**	
		PIPE SUPPORT HARDWARE	
	35.41.00	**VALVES**	
		Valves	IA, service water, potable water, allowance
		Pressure regulators, self contained	Water and air, allowance
		VALVES	
	35.99.00	**Piping, User Defined**	
		ss braided flex hose, flanged	Lube oil supply (motor)
		ss braided flex hose, flanged	Lube oil supply (fan)
		ss braided flex hose, flanged	Lube oil return (motor)
		ss braided flex hose, flanged	Lube oil return (fan)

Group	Phase	Description	Notes
		BOP Specialties, including duplex strainers	Allowance
		Piping, User Defined	
		PIPING	
36.00.00		**INSULATION**	
	36.13.00	**Insulation, Duct**	
		Mineral wool insulation 4" thk, 8 lb/cf density, aluminum lagging - installed in place	ESP outlets to baghouse
		Mineral wool insulation 4" thk, 8 lb/cf density, aluminum lagging - installed in place	Baghouse outlet to ID fan tie points
		Mineral wool insulation 4" thk, 8 lb/cf density, aluminum lagging - installed in place	Baghouse casing
		Mineral wool insulation 6" thk, 8 lb/cf density, aluminum lagging - installed in place	Baghouse hoppers
		Mineral wool insulation & lagging incl removable panels - installed in place	New booster fans (QTY 2)
		Mineral wool insulation & lagging incl removable panels - installed in place	Replace insulation removed for fan reinforcement
		Mineral wool insulation 4" thk, 8 lb/cf density, aluminum lagging - installed in place	Duct between fans, A&B train
		Insulation, Duct	
	36.15.00	**Insulation, Equipment**	
		Extend compressed air header to new aci blower / electrical building	
		Cross tie with existing boiler building instrument air system	
		Potable water riser to new baghouse ee building battery room eyewash stations	
		Service water piping from grade up to baghouse	
		Service water to ash silo pin mixer	
		Service water DSI mill	
		IA to ACI / DSI blower building	
		Insulation, Equipment	
		INSULATION	
41.00.00		**ELECTRICAL EQUIPMENT**	
	41.13.00	**Bus Duct**	
		From new T3-1 Y-wind to new 4.16KV SWGR-3A (main feed)	
		Bus Duct	
	41.13.45	**Bus Duct, Iso Phase, Self Cooled**	
		Bus Duct, Iso Phase Modifications	Shorten bus duct to accommodate larger 132kv-4.16kv transformer
		Bus Duct, Iso Phase, Self Cooled	
	41.15.00	**Cathodic Protection**	
		Cathodic protection system	
		Cathodic Protection	
	41.17.00	**Communication System**	
		Communication system	
		Communication System	
	41.21.00	**Control & Backup Power**	
		UPS testing & adjustments	
		UPS- 5kva, 5kva bypass transformer, 150a, 120vac panel	
		Self contained UPS battery charger, 120 vac, 5 kva, 20 ah battery	
		Control & Backup Power	
	41.23.00	**Motors**	
		Test	Test & debug and documentations
		7000HP ID Booster fan motors	4160V Across-the-line, including couplings
		Motors	
	41.31.00	**Electrical Equipment,Grounding**	
		Bare copper wire, 500 kcmil	Underground for station ground grid
		Bare copper wire, 4/0	Equipment grounding connection
		Exothermic weld	Bare copper wire, 4/0
		Insulated ground copper wire, 4/0	DCS ground cable from copper bar in bh bldg to station ground grid
		Rod, copper clad 20' long, 3/4" dia	
		Brazed Connection	Bare copper wire, 500 kcmil
		Equipment Grounding	
		Electrical Equipment,Grounding	
	41.33.00	**Heat Tracing**	
		Heat trace transformers, 480-120/208v 3 phase, 45 kva, square d, cutler hammer	

Group	Phase	Description	Notes
		Heat trace power and monitor panels, each with twelve 30a breakers and eight-15a breakers, square d, cutler hammer	
		1.5" pipe heat tracing cable	
		2" pipe heat tracing cable	
		4" pipe heat tracing cable	
		Obrien enclosures	
		Vendor field assistance	
		Heat tracing engineering	
		Heat Tracing	
	41.35.00	**Lightning Protection**	
		Lightning protection	ACI silo, Baghouse, DSI silo
		Lightning Protection	
	41.37.00	**Lighting Accessory (Fixture)**	
		Exterior hid fixtures, wall mounted 150 watt	
		Interior fluorescent fixtures, 2'w x 4'l, two 40 watt	
		Lighting support (light fixtures)	
		Lighting Accessory (Fixture)	
	41.45.00	**Motor Control Center (MCC), Complete**	
		MCCs testing & calibrations	Test & debug and documentations
		480V motor control center, 600a,nema12	ACI MCCs
		480V motor control center, 600a, nema12	DSI MCCs
		480V motor control center, 1200a, nema12	Baghouse MCCs
		Motor Control Center (MCC), Complete	
	41.47.00	**Panel: Control, Distribution, & Relay**	
		lighting panels, 277/480v three phase, 42 circuits, square d or cutler hammer	
		lighting panels, 120/208v three phase, 30 circuits, square d or cutler hammer	
		480 vac power panels, 100a, 24 circuit, square d or cutler hammer (indoor)	
		480 vac power panels, 600a, 24 circuit, square d or cutler hammer (indoor)	
		Panel: Control, Distribution, & Relay	
	41.51.00	**Power Transformer**	
		3 winding, 22kv-4.16kv-4.16kv, HV 30/40/50 MVA, LV 21/28/35 MVA, LV 15/20/25 MVA	
		3 winding, 138kv-4.16kv-4.16kv, HV 40/53.3/66.7 MVA, LV 22.2/29.6/37 MVA, LV 30/40/50 MVA	
		Test	
		75KVA, 480-480/277V, 3 PHASE	Lighting transformers
		30KVA, 480-480/277V, 3 PHASE	Lighting transformers
		15KVA, 480-120/208V, 3 PHASE	Lighting transformers
		Isolation transformer, 480-120/208 vac, 1-phase, 25 kva, wall mounted (indoor rated)	
		2000/2666KVA, 6.9KV-480V Unit Substation Transformers (dry ventilated/indoor)	No housekeeping pad req'd
		Power Transformer	
	41.55.00	**Switchgear, Complete**	
		Switchgear testing & calibrations	Test & debug and documentations
		480V Switchgear, 3200A, 2-3200A MAIN BRKRS, 1-3200A TIE BRKR,	Indoor rated load center
		4.16KV Switchgear, 2000A, 500MVA, ARC RESISTANT, 1 - 2000A MAIN BRKR, 1 - 2000A RESERVE BRKR,	New PDC incl building and equipment, SWGR-3A,
		Switchgear, Complete	
	41.57.00	**Wiring Device**	
		480 VAC Welding Receptacles (60 AMP), OZ GEDNEY WSR6352 WITH APJ PLUG, outdoor rated	
		480 VAC Power outlets (60 AMP), OZ GEDNEY AREA6585 outdoor rated	
		120 VAC Convenience outlets	
		Wiring Device	
		ELECTRICAL EQUIPMENT	
42.00.00		**RACEWAY, CABLE TRAY & CONDUIT**	
	42.13.00	**Cable Tray**	
		18" wide alum. ladder cable tray	
		18" wide alum. cable tray cover	

Group	Phase	Description	Notes
		36" wide alum. ladder cable tray	
		Cable Tray	
	42.15.00	**Conduit**	
		conduit	
		flex conduit	
		Conduit	
	42.17.00	**Conduit Box**	
		Local junction boxes with terminal blocks, nema 4x fiberglass	
		Local junction boxes with terminal blocks, nema 4x fiberglass	
		Pull boxes, nema 4x fiberglass	
		Conduit Box	
	42.99.00	**Raceway, Cable Tray, & Conduit, User Defined**	
		Concrete duct bank (BEEE to ACI EE/MEB)	
		Concrete duct bank (DSI EE/MEB TO DSI SILO)	
		Concrete duct bank (BEEE TO DSI EE/MEB)	
		Concrete duct bank (ACI EE/MEB TO ACI SILO)	
		Concrete duct bank (Ash vacuum exhausters to nearby try)	
		Underground Survey	
		Raceway, Cable Tray, & Conduit, User Defined	
		RACEWAY, CABLE TRAY & CONDUIT	
43.00.00		**CABLE**	
	43.13.00	**Control & Instrument Cable**	
		FIBER OPTIC (6 FIBER 12/C)	
		FIBER OPTIC (12 FIBER 12/C)	
		2/C #10 AWG 600V	
		4/C #10 AWG 600V	
		2/C #14 AWG 600V	
		1 PR #16 AWG TSP	
		2 PR #16 AWG TSP	
		4 PR #16 AWG TSP	
		4 PR #23 CAT-6 (Ethernet 5e)	
		5/C #14 AWG 600V	
		7/C #14 AWG 600V	
		9/C #14 AWG 600V	
		12/C #14 AWG 600V	
		19/C #14 AWG 600V	
		#10 AWG TERMINATIONS	
		#14 AWG TERMINATIONS	
		#16 THERMOCOUPLE WIRE TERMINATIONS	
		FIBER OPTIC TERMINATIONS	
		CAT-6 ETHERNET CABLE TERMINATION (RJ45)	
		Control & Instrument Cable	
	43.17.25	**Medium Voltage Power Cable, 8 KV**	
		Medium Voltage Power Cable, 8 KV	1/C #500 KCML
		Medium Voltage Power Cable, 8 KV	1/C #750 KCML
		#500 KCML Terminations	Wire tag & documentation
		#750 KCML Terminations	Wire tag & documentation
		Medium Voltage Power Cable, 8 KV	
	43.21.15	**Low Voltage Power Cable, 600 V**	
		Low Voltage Power Cable, 600 V 1 /c # 750 kcmil	
		Low Voltage Power Cable, 600 V 1 /c # 500 kcmil	
		Low Voltage Power Cable, 600 V 1 /c # 350 kcmil	
		Low Voltage Power Cable, 600 V 1 /c # 12 awg	For lighting
		Low Voltage Power Cable, 600 V 3 /c # 4/0 awg	
		Low Voltage Power Cable, 600 V 3 /c # 2/0 awg	
		Low Voltage Power Cable, 600 V 3 /c # 1/0 awg	
		Low Voltage Power Cable, 600 V 4 /c # 1/0 awg	
		Low Voltage Power Cable, 600 V 3 /c # 2 awg	
		Low Voltage Power Cable, 600 V 3 /c # 4 awg	
		Low Voltage Power Cable, 600 V 3 /c # 6 awg	
		Low Voltage Power Cable, 600 V 3 /c # 10 awg	
		Low Voltage Power Cable, 600 V 4 /c # 4/0 awg	
		Low Voltage Power Cable, 600 V 4 /c # 2 awg	

Group	Phase	Description	Notes
		Low Voltage Power Cable, 600 V	
	43.21.35	**Low Voltage Power Cable, Termination**	
		Low Voltage Power Cable, #750 kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #500 kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #350 kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #4/0 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #2/0 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #1/0 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #2 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #4 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #6 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #12 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, #10 AWG kcml Termination	Wire tag & documentation
		Low Voltage Power Cable, Termination	
	43.21.99	**Low Voltage Power Cable & Termination**	
		Low Voltage Power Cable & Termination, Testing	Wire testing & documentation
		Low Voltage Power Cable & Termination	
		CABLE	
44.00.00		**CONTROL & INSTRUMENTATION**	
	44.13.00	**Control System**	
		I/O Loop testing - Field verification	Baghouse, ACI, DSI SYSTEM
		DCS cabinet installation	Baghouse, ACI, DSI SYSTEM
		I/O Loop testing - Field verification	AH.AP, FIRE. DET., INST. AIR
		DCS cabinet installation (panel cost by others)	AH.AP, FIRE. DET., INST. AIR
		Cabinets, I/O point programming, labeling, documentation	Baghouse, ACI, DSI SYSTEM
		Control System	
	44.21.00	**Instrument**	
		Test & Startup	Test & debug and documentations
		Implosion protection-trip redundant pressure transmitters	
		Proven air flow on ID Booster fans	
		Local devices not wired by baghouse contractor	
		Monitoring Equipment	ID Booster fan vibration
		Instrument	
	44.25.27	**Continuous Emission Monitoring System (CEMS)**	
		Continuous Emission Monitoring System (CEMS)	PM CEMS
		Continuous Emission Monitoring System (CEMS)	Hg CEMS
		Continuous Emission Monitoring System (CEMS)	HCL CEMS
		Continuous Emission Monitoring System Shelter	
		Continuous Emission Monitoring System (CEMS)	
		CONTROL & INSTRUMENTATION	
61.00.00		**CONSTRUCTION INDIRECT - Major Equip.**	
	61.13.00	**Construction Indirect, Construction Equipment**	
		Construction Indirect, Construction Equipment, incl mob / demob, & operators	1 Crane, Manitowoc 18000, Incl. Mob & Demob and Operator
		Construction Indirect, Construction Equipment, incl mob / demob, & operators	Tower crane; 1 Crane, Incl. Mob & Demob and Operator
		Construction Indirect, Construction Equipment	
		CONSTRUCTION INDIRECT - Major Equip.	
71.00.00		**PROJECT INDIRECT - Conditions Assesments**	
	71.99.00	**Project Indirect, User Defined**	
		Flue gas train transient pressure analysis	
		ESP/SCR OEM Engineering assesment for revised draft/transient	
		Project Indirect, User Defined	
		PROJECT INDIRECT - Conditions Assesments	
91.00.00		**CONSTRUCTION INDIRECTS**	
93.00.00		**PROJECT INDIRECTS**	
94.00.00		**CONTIGENCY**	
96.00.00		**ESCALLATION**	



LEGEND	
UNIT 2	
1	BAGHOUSE (ELEVATED OVER U1 ESP)
2	BOOSTER FANS (7,000 HP)
3	REPLACE EXIST VAT 2B
4	6.9KV SWITCHGEAR PDC)
5	BAGHOUSE ELECT. EQUIP ENCLOSURE PDC (BETWEEN HOPPER BAYS)
6	AIR COMPRESSOR ENCLOSURE (BETWEEN HOPPER BAYS)
7	RELOCATE DEMIN AND SW TANKS (3 TANKS)
8	MODIFY BYPASS DAMPER
9	BH INLET/OUTLET DUCTWORK
10	DEMO UNIT 2 ESP
11	UNIT 1&2 ACI SILO & ELEC BUILDING
12	UNIT 1&2 DSI SILO & ELEC BUILDING
13	SHEET PILING & FILL
14	MODIFY FENCE, NEW GATE & GRAVEL ROAD TO INTAKE
15	FLY ASH TRANSFER SYSTEM
16	CONSTRUCTION CRANE LOCATION
17	ELEVATOR (TO ASH HOPPER FLOOR)
18	ACI/DSI PIPING & PIPE SUPPORTS SCR
19	✱ DSI INJECTION LOCATION (AFTER SCR) (TYP.)
20	◀ ACI INJECTION LOCATION (BEFORE BH) (TYP.)
21	NEW UNIT 2 HYDROVEYOR (ELEVATED AT BH PLATFORM)
22	PATH TO MOVE WATER TANKS OUT (LIFT OVER PIPERACK TO ROAD)

UNIT 3	
51	BAGHOUSE (ON EXIST U2 ESP FOUNDATION)
52	BOOSTER FANS (7000 HP)
53	REPLACE EXISTING UAT T3-1 & T3-2
54	4160KV SWITCHGEAR PDC
55	BAGHOUSE ELECT EQUIP ENCLOSURE PDC (BETWEEN HOPPER BAYS)
56	AIR COMPRESSOR ENCLOSER (BETWEEN HOPPER BAYS)
59	BH INLET/OUTLET DUCTWORK
61	UNIT 3&4 ACI SILO & ELECT BUILDING
62	UNIT 3&4 DSI SILO & ELECT BUILDING
65	FLY ASH TRANSFER STATION
66	CONSTRUCTION CRANE LOCATION (MANITOWOC 18,000)
67	CONSTRUCTION TOWER CRANE (LUFFING JIB TYPE)
68	ACI/DSI PIPING & PIPE SUPPORTS
69	✱DSI INJECTION LOCATION (AFTER SCR) (TYP.)
70	◀ ACI INJECTION LOCATION (BEFORE BH) (TYP.)

HOLD INFORMATION	
NO.	DESCRIPTION

CONTRACTOR/INSTALLER SHALL TAKE ALL APPROPRIATE PRECAUTIONS TO ENSURE THE SAFETY OF ALL PEOPLE LOCATED ON THE WORK SITE, INCLUDING CONTRACTOR'S/INSTALLER'S PERSONNEL (OR THAT OF ITS SUB-CONTRACTOR(S)) PERFORMING THE WORK.

RELEASE INFORMATION		
REV.	DATE	DESCRIPTION
0	12-16-2011	FOR CLIENT COMMENT
1	06-06-2011	FOR CLIENT COMMENT

ISSUE PURPOSE:

SPECIFICATION:

PROJECT NO.: 13002-000

I HEREBY CERTIFY THAT THIS ENGINEERING DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT PERSONAL SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF ENTER NAME.

ENTER NAME
ENTER DATE

MY LICENSE RENEWAL DATE IS: ENTER DATE
PAGES OR SHEETS COVERED BY THIS SEAL:
THIS DOCUMENT ONLY.

CERTIFICATE OF AUTHORIZATION (WHEN REQ'D)

CAD FILE NAME: SK-GA-IPL-PB-001B.DGN

PREPARED BY: R.MILLER

REVIEWED BY: L.ILLINGWORTH

APPROVED BY:

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Sargent & Lundy LLC

SARGENT & LUNDY LLC
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603-5780

ipl an AES company

PROJECT

PETERSBURG

UNIT 2 & 3

INDIANAPOLIS POWER & LIGHT

DRAWING TITLE

PRELIMINARY
GENERAL ARRANGEMENT
BAGHOUSE RETROFIT

DRAWING NUMBER	REVISION
SK-GA-IPL-PB-001B	1
SHEET 1 OF 1	

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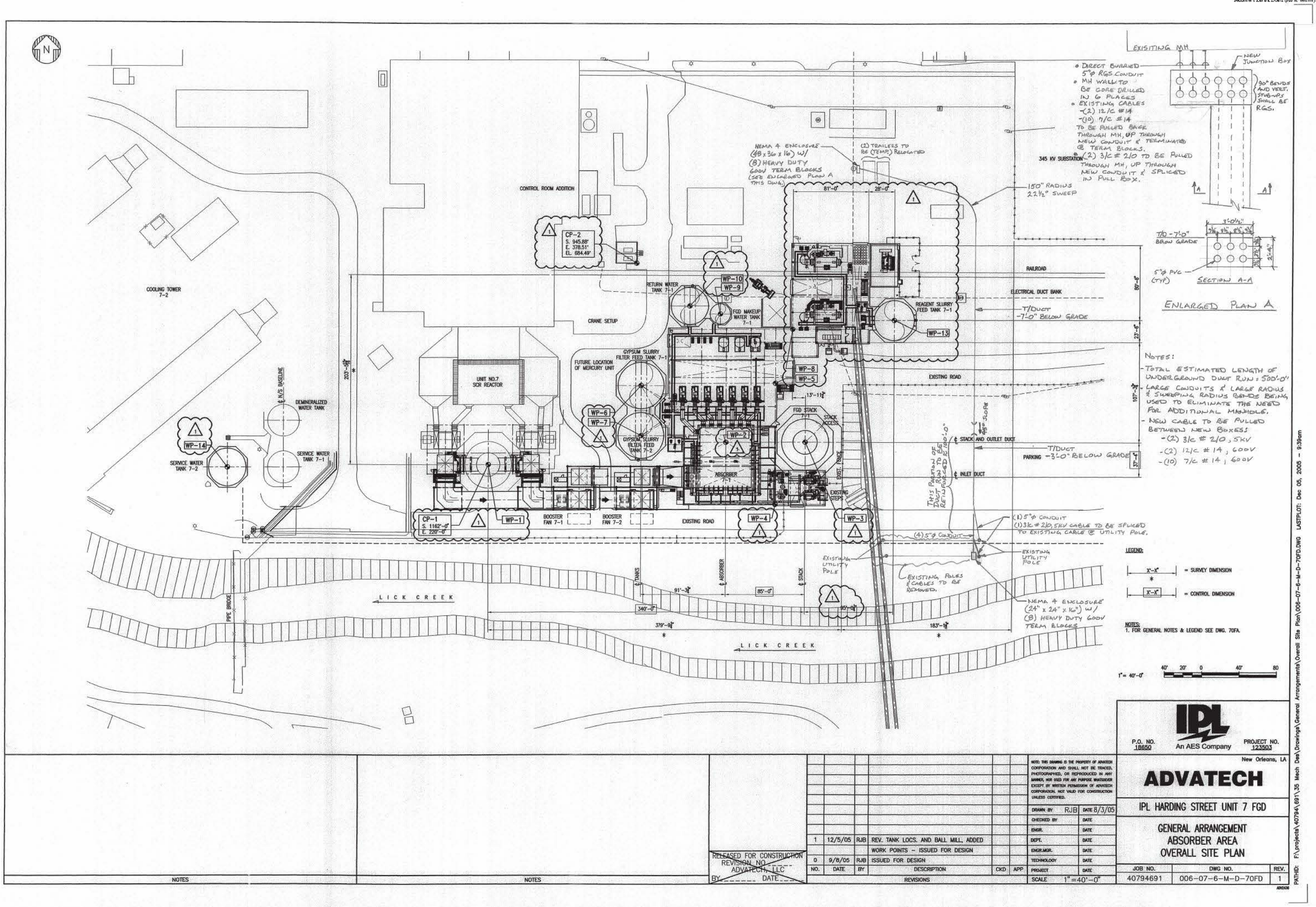
EXISITING MH
NEW JUNCTION BOX
• DIRECT BURRIED 5"φ RGS CONDUIT
• MH WALL TO BE CORE DRILLED IN 6 PLACES
• EXISTING CABLES
-(2) 12/C #14
-(10) 7/C #14
TO BE PULLED BACK THROUGH MH, UP THROUGH NEW CONDUIT & TERMINATED @ TERM BLOCKS.
• (2) 3/C # 2/0 TO BE PULLED THROUGH MH, UP THROUGH NEW CONDUIT & SPLICED IN PULL BOX.
90° BENDS AND VERT. STUB-UPS SHALL BE RGS.
T/D - 7'-0" BELOW GRADE
3'-0½"
5"φ PVC (TYP)
SECTION A-A
ENLARGED PLAN A
NOTES:
- TOTAL ESTIMATED LENGTH OF UNDERGROUND DUCT RUN: 500'-0"
- LARGE CONDUITS & LARGE RADIUS & SWEEPING RADIUS BENDS BEING USED TO ELIMINATE THE NEED FOR ADDITIONAL MANHOLE.
- NEW CABLE TO BE PULLED BETWEEN NEW BOXES:
-(2) 3/C # 2/0, 5KV
-(2) 12/C # 14, 600V
-(10) 7/C # 14, 600V
345 KV SUBSTATION
150" RADIUS 22½° SWEEP
CONTROL ROOM ADDITION
CP-2
COOLING TOWER 7-2
RAILROAD
ELECTRICAL DUCT BANK
T/DUCT -7'-0" BELOW GRADE
RETURN WATER TANK 7-1
FGD MAKEUP WATER TANK 7-1
REAGENT SLURRY FEED TANK 7-1
CRANE SETUP
UNIT NO.7 SCR REACTOR
FUTURE LOCATION OF MERCURY UNIT
GYPSUM SLURRY FILTER FEED TANK 7-1
GYPSUM SLURRY FILTER FEED TANK 7-2
DEMINERALIZED WATER TANK
SERVICE WATER TANK 7-2
SERVICE WATER TANK 7-1
ABSORBER 7-1
FGD STACK
STACK ACCESS
STACK AND OUTLET DUCT
INLET DUCT
T/DUCT -3'-0" BELOW GRADE
PARKING
EXISTING ROAD
EXISTING STEPS
BOOSTER FAN 7-1
BOOSTER FAN 7-2
CP-1
WP-1
WP-2
WP-3
WP-4
WP-5
WP-6
WP-7
WP-8
WP-9
WP-10
WP-13
WP-14
(1) 5"φ CONDUIT
(1) 3/C # 2/0, 5KV CABLE TO BE SPLICED TO EXISTING CABLE @ UTILITY POLE.
(4) 5"φ CONDUIT
EXISTING UTILITY POLE
EXISTING POLES & CABLES TO BE REMOVED.
NEMA 4 ENCLOSURE (24" x 24" x 16") w/ (8) HEAVY DUTY 600V TERM BLOCKS
NEMA 4 ENCLOSURE (48 x 36 x 16) w/ (8) HEAVY DUTY 600V TERM BLOCKS (SEE ENLARGED PLAN A THIS DWG)
(2) TRAILERS TO BE (TEMP) RELOCATED
LICK CREEK
PIPE BRIDGE
LEGEND:
= SURVEY DIMENSION
= CONTROL DIMENSION
NOTES:
1. FOR GENERAL NOTES & LEGEND SEE DWG. 70FA.
1" = 40'-0"
P.O. NO. 18650
An AES Company
PROJECT NO. 123503
New Orleans, LA
ADVATECH
NOTE: THIS DRAWING IS THE PROPERTY OF ADVATECH CORPORATION AND SHALL NOT BE TRACED, PHOTOGRAPHED, OR REPRODUCED IN ANY MANNER, NOR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN PERMISSION OF ADVATECH CORPORATION. NOT VALID FOR CONSTRUCTION UNLESS CERTIFIED.
IPL HARDING STREET UNIT 7 FGD
GENERAL ARRANGEMENT ABSORBER AREA OVERALL SITE PLAN
DRAWN BY RJB DATE 8/3/05
CHECKED BY DATE
ENGR. DATE
DEPT. DATE
ENGR.MGR. DATE
TECHNOLOGY DATE
PROJECT DATE
SCALE 1"=40'-0"
JOB NO. 40794691
DWG NO. 006-07-6-M-D-70FD
REV. 1
1 12/5/05 RJB REV. TANK LOCS. AND BALL MILL, ADDED WORK POINTS - ISSUED FOR DESIGN
0 9/8/05 RJB ISSUED FOR DESIGN
NO. DATE BY DESCRIPTION CKD APP
REVISIONS
RELEASED FOR CONSTRUCTION REVISION NO. ADVATECH, LLC BY DATE
NOTES
NOTES
PATHID: F:\projects\40794\691\35 Mech Des\Drawings\General Arrangements\Overall Site Plan\006-07-6-M-D-70FD.DWG LASTPLOT: Dec 05, 2005 - 9:39am

APPENDIX E.
Petersburg Station Economic Evaluation

IURC Cause No. 44242
Petitioner's Exhibit DGS-2 (Public Version)

Appendix E

Predicted Total Hg Emissions for Petersburg Station Based on Coals with Various Hg Contents

Performance Based on Maximum of 8 lb/TBtu Hg Coal & With Unit 2 Re-Emission of Hg from FGD

With ESPs

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	89	88	89
Stack Emission Rate (lb/TBtu)	0.64	0.88	0.96	0.88
Weighted Contribution to Station total (lb/TBtu)	0.08	0.21	0.31	0.26
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.87			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.12	0.31	0.45	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.87			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	258	279
Station Capital and O&M Cost NPV ($ Million)	966			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	197			
Station Total NPV ($ Million)	1163			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	258	279
Station Capital and O&M Cost NPV ($ Million)	966			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	398			
Station Total NPV ($ Million)	1364			

Baghouse at Unit 2

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	88	89
Stack Emission Rate (lb/TBtu)	0.64	0.56	0.96	0.88
Weighted Contribution to Station total (lb/TBtu)	0.08	0.13	0.31	0.26
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.80			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.11	0.00	0.40	0.37
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.87			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	279
Station Capital and O&M Cost NPV ($ Million)	991			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	197			
Station Total NPV ($ Million)	1188			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	279
Station Capital and O&M Cost NPV ($ Million)	991			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	398			
Station Total NPV ($ Million)	1389			

Baghouse at Unit 2 and 3

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	95	89
Stack Emission Rate (lb/TBtu)	0.64	0.56	0.42	0.88
Weighted Contribution to Station total (lb/TBtu)	0.08	0.13	0.13	0.26
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.62			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.12	0.19	0.00	0.41
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.72			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	279
Station Capital and O&M Cost NPV ($ Million)	1054			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	197			
Station Total NPV ($ Million)	1251			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	279
Station Capital and O&M Cost NPV ($ Million)	1054			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	398			
Station Total NPV ($ Million)	1452			

Baghouse at Unit 2 and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	88	95
Stack Emission Rate (lb/TBtu)	0.64	0.56	0.96	0.40
Weighted Contribution to Station total (lb/TBtu)	0.08	0.13	0.31	0.13
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.65			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.12	0.20	0.45	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.76			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	369
Station Capital and O&M Cost NPV ($ Million)	1081			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	197			
Station Total NPV ($ Million)	1278			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	369
Station Capital and O&M Cost NPV ($ Million)	1081			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	398			
Station Total NPV ($ Million)	1479			

Baghouse at Unit 3 and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	89	95	95
Stack Emission Rate (lb/TBtu)	0.64	0.88	0.40	0.40
Weighted Contribution to Station total (lb/TBtu)	0.08	0.21	0.13	0.13
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.54			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.12	0.31	0.19	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.61			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	321	369
Station Capital and O&M Cost NPV ($ Million)	1119			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	197			
Station Total NPV ($ Million)	1316			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	321	369
Station Capital and O&M Cost NPV ($ Million)	1119			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	398			
Station Total NPV ($ Million)	1517			

Baghouse at Units 2, 3, and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	95	95
Stack Emission Rate (lb/TBtu)	0.64	0.56	0.40	0.40
Weighted Contribution to Station total (lb/TBtu)	0.08	0.13	0.13	0.13
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.47			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.12	0.20	0.19	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.50			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	369
Station Capital and O&M Cost NPV ($ Million)	1144			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	197			
Station Total NPV ($ Million)	1341			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	369
Station Capital and O&M Cost NPV ($ Million)	1144			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	398			
Station Total NPV ($ Million)	1542			

Performance Based on Maximum of 8 lb/TBtu Hg Coal & With Unit 2 Re-Emission of Hg from FGD

With ESPs

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	89	88	89
Stack Emission Rate (lb/TBtu)	0.72	0.99	1.08	0.99
Weighted Contribution to Station total (lb/TBtu)	0.09	0.24	0.34	0.32
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.98			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	[illegible]	[illegible]	[illegible]	[illegible]
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.98			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	258	279
Station Capital and O&M Cost NPV ($ Million)	966			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	122			
Station Total NPV ($ Million)	1088			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	258	279
Station Capital and O&M Cost NPV ($ Million)	966.00			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	268			
Station Total NPV ($ Million)	1234			

Baghouse at Petersburg Unit 2

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	88	89
Stack Emission Rate (lb/TBtu)	0.72	0.63	1.08	0.99
Weighted Contribution to Station total (lb/TBtu)	0.09	0.15	0.34	0.32
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.90			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.12	0.00	0.45	0.41
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.98			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	279
Station Capital and O&M Cost NPV ($ Million)	991			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	123			
Station Total NPV ($ Million)	1114			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	279
Station Capital and O&M Cost NPV ($ Million)	991			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	268			
Station Total NPV ($ Million)	1259			

Baghouse at Unit 2 and 3

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	95	89
Stack Emission Rate (lb/TBtu)	0.72	0.63	0.45	0.99
Weighted Contribution to Station total (lb/TBtu)	0.09	0.15	0.14	0.32
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.70			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.13	0.22	0.00	0.46
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.81			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	279
Station Capital and O&M Cost NPV ($ Million)	1054			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	123			
Station Total NPV ($ Million)	1177			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	279
Station Capital and O&M Cost NPV ($ Million)	1054			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	268			
Station Total NPV ($ Million)	1322			

Baghouse at Unit 2 and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	88	95
Stack Emission Rate (lb/TBtu)	0.72	0.63	1.08	0.45
Weighted Contribution to Station total (lb/TBtu)	0.09	0.15	0.34	0.14
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.73			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.13	0.22	0.50	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.86			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	369
Station Capital and O&M Cost NPV ($ Million)	1081			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	123			
Station Total NPV ($ Million)	1204			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	369
Station Capital and O&M Cost NPV ($ Million)	1081			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	268			
Station Total NPV ($ Million)	1349			

Baghouse at Unit 3 and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	89	95	95
Stack Emission Rate (lb/TBtu)	0.72	0.99	0.45	0.45
Weighted Contribution to Station total (lb/TBtu)	0.09	0.24	0.14	0.14
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.61			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.13	0.34	0.21	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.69			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	321	369
Station Capital and O&M Cost NPV ($ Million)	1119			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	123			
Station Total NPV ($ Million)	1242			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	321	369
Station Capital and O&M Cost NPV ($ Million)	1119			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	268			
Station Total NPV ($ Million)	1387			

Baghouse at Units 2, 3, and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	95	95
Stack Emission Rate (lb/TBtu)	0.72	0.63	0.45	0.45
Weighted Contribution to Station total (lb/TBtu)	0.09	0.15	0.14	0.14
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.53			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.13	0.22	0.21	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.56			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	369
Station Capital and O&M Cost NPV ($ Million)	1144			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	123			
Station Total NPV ($ Million)	1267			
Net Present Value of Option with [redacted] Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	369
Station Capital and O&M Cost NPV ($ Million)	1144			
Station Fuel Cost Differential @[redacted]/Ton ($ Million)	268			
Station Total NPV ($ Million)	1412			

Performance Based on Maximum of 11.2 lb/TBtu Hg Coal & With Unit 2 Re-Emission of Hg from FGD

With ESPs

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	89	88	89
Stack Emission Rate (lb/TBtu)	0.90	1.23	1.34	1.23
Weighted Contribution to Station total (lb/TBtu)	0.11	0.29	0.43	0.39
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	1.22			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	[illegible]	[illegible]	[illegible]	[illegible]
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	1.22			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	258	279
Station Capital and O&M Cost NPV ($ Million)	966			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	966			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	258	279
Station Capital and O&M Cost NPV ($ Million)	966			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	966			

Baghouse at Petersburg Unit 2

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	88	89
Stack Emission Rate (lb/TBtu)	0.90	0.75	1.34	1.23
Weighted Contribution to Station total (lb/TBtu)	0.11	0.19	0.43	0.39
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	1.12			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	[illegible]	[illegible]	[illegible]	[illegible]
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	1.22			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	279
Station Capital and O&M Cost NPV ($ Million)	991			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	991			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	279
Station Capital and O&M Cost NPV ($ Million)	991			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	991			

Baghouse at Unit 2 and 3

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	95	89
Stack Emission Rate (lb/TBtu)	0.90	0.75	0.56	1.23
Weighted Contribution to Station total (lb/TBtu)	0.11	0.19	0.18	0.39
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.87			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.17	0.27	0.00	0.57
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	1.01			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	279
Station Capital and O&M Cost NPV ($ Million)	1054			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1054			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	279
Station Capital and O&M Cost NPV ($ Million)	1054			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1054			

Baghouse at Unit 2 and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	88	95
Stack Emission Rate (lb/TBtu)	0.90	0.75	1.34	0.56
Weighted Contribution to Station total (lb/TBtu)	0.11	0.19	0.43	0.18
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.90			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.17	0.27	0.63	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	1.07			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	369
Station Capital and O&M Cost NPV ($ Million)	1081			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1081			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	258	369
Station Capital and O&M Cost NPV ($ Million)	1081			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1081			

Baghouse at Unit 3 and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	89	95	95
Stack Emission Rate (lb/TBtu)	0.90	1.23	0.56	0.56
Weighted Contribution to Station total (lb/TBtu)	0.11	0.29	0.18	0.18
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.76			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.17	0.43	0.26	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.86			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	321	369
Station Capital and O&M Cost NPV ($ Million)	1119			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1119			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	298	321	369
Station Capital and O&M Cost NPV ($ Million)	1119			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1119			

Baghouse at Units 2, 3, and 4

	Pete 1	Pete 2	Pete 3	Pete 4
ACI + FGD Removal Efficiency (%)	92	93	95	95
Stack Emission Rate (lb/TBtu)	0.90	0.75	0.56	0.56
Weighted Contribution to Station total (lb/TBtu)	0.11	0.19	0.18	0.18
Station Average Hg Emission rate with all Units Operating (lb/TBtu)	0.66			
Station Hg Total Emission Rate Goal (lb/TBtu)	0.9 on 90-day average			
Weighted Contribution to Station total (lb/TBtu)	0.17	0.27	0.26	0.00
Station Average Hg Emission rate with Large Unit in Outage (lb/TBtu)	0.70			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	369
Station Capital and O&M Cost NPV ($ Million)	1144			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1144			
Net Present Value of Option with $0/Ton Differential				
Unit Capital and O&M Cost NPV ($ Million)	131	323	321	369
Station Capital and O&M Cost NPV ($ Million)	1144			
Station Fuel Cost Differential @ $0/Ton ($ Million)	0			
Station Total NPV ($ Million)	1144			

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APPENDIX F.
HARDING STREET STATION UNIT 7 Economic Evaluation

Predicted Total Hg Emissions for Harding Street Unit 7 Based on Coals with Various Hg Contents

	With ESP	Baghouse
	HS 7	HS 7
Performance Based on a Maximum of 6 lb/TBtu Hg Coal & No Re-Emission of Hg from FGD		
ACI + FGD Removal Efficiency (%)	95	95
Stack Emission Rate (lb/TBtu)	0.30	0.30
Weighted Contribution to Station total (lb/Tbtu)	N/A	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	N/A	N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	**1.0 on 30-day average**	**1.0 on 30-day average**
Weighted Contribution to Station total (lb/Tbtu)	N/A	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	N/A	N/A
Net Present Value of Option with $0/Ton Differential		
Unit Capital and O&M Cost NPV ($ Million)	157	317
Station Capital and O&M Cost NPV ($ Million)	157	317
Station Fuel Cost Differential @ **$0/Ton** ($ Million)	0.00	0.00
Station Total NPV ($ Million)	157	317
Net Present Value of Option with $0/Ton Differential		
Unit Capital and O&M Cost NPV ($ Million)	157	317
Station Capital and O&M Cost NPV ($ Million)	157	317
Station Fuel Cost Differential @ **$0/Ton** ($ Million)	0.00	0.00
Station Total NPV ($ Million)	157	317

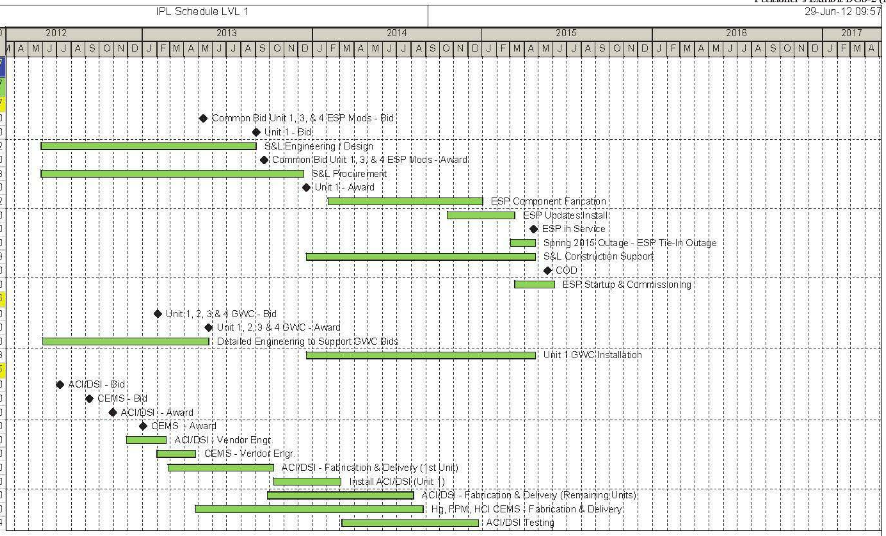
	With ESP	Baghouse
	HS 7	HS 7
Performance Based on a Maximum of 9 lb/TBtu Hg Coal & No Re-Emission of Hg from FGD		
ACI + FGD Removal Efficiency (%)	95	95
Amount of Collected Oxidized Hg Re-emitted (%)	0	0
Stack Emission Rate (lb/TBtu)	0.45	0.45
Weighted Contribution to Station total (lb/Tbtu)	N/A	N/A
Station Average Hg Emission rate with all Units Operating (lb/Tbtu)	N/A	N/A
Station Hg Total Emission Rate Goal (lb/TBtu)	**1.0 on 30-day average**	**1.0 on 30-day average**
Weighted Contribution to Station total (lb/Tbtu)	N/A	N/A
Station Average Hg Emission rate with Large Unit in Outage (lb/Tbtu)	N/A	N/A
Net Present Value of Option with $0/Ton Differential		
Unit Capital and O&M Cost NPV ($ Million)	157	317
Station Capital and O&M Cost NPV ($ Million)	157	317
Station Fuel Cost Differential @ **$0/Ton** ($ Million)	0	0
Station Total NPV ($ Million)	157	317
Net Present Value of Option with $0/Ton Differential		
Unit Capital and O&M Cost NPV ($ Million)	157	317
Station Capital and O&M Cost NPV ($ Million)	157	317
Station Fuel Cost Differential @ **$0/Ton** ($ Million)	0	0
Station Total NPV ($ Million)	157	317

APPENDIX G.
MILESTONE SCHEDULES
PETERSBURG STATION UNITS 1-4
HARDING STREET STATION UNIT 7

IPL Schedule LVL 1

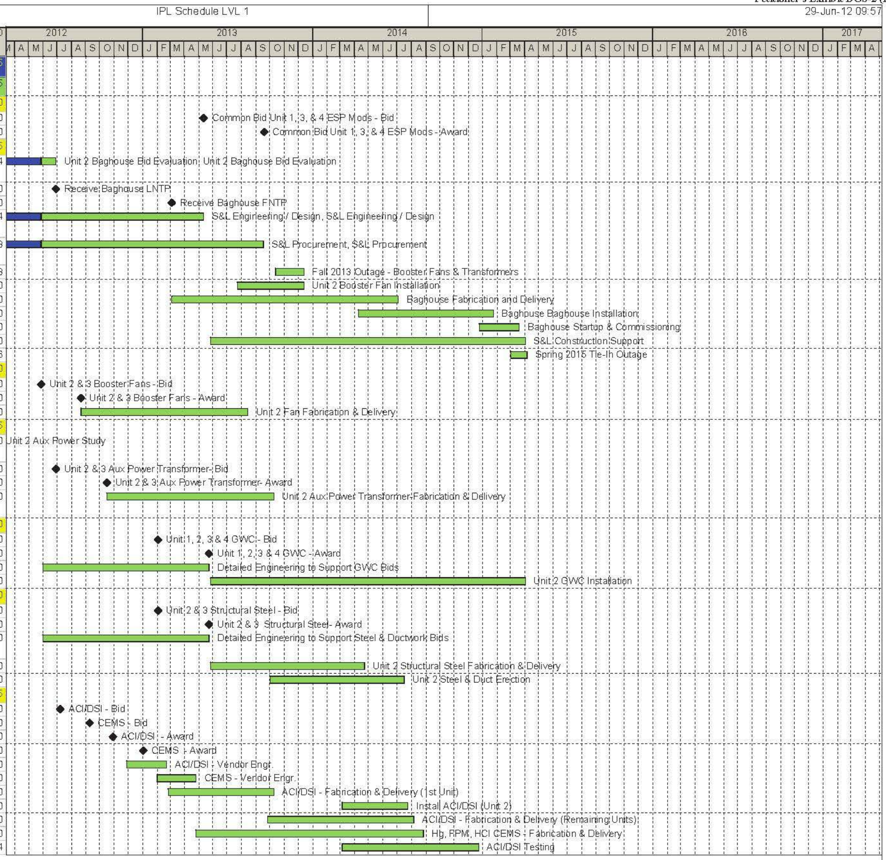
29-Jun-12 09:57

Activity ID	Activity Name	Start	Finish	RD
IPL Petersburg U1 - LVL 1 Schedule		29-May-12	04-Jun-15	767
Petersburg Station		29-May-12	04-Jun-15	767
Unit 1		29-May-12	04-Jun-15	767
U1-A1050	Common Bid Unit 1, 3, & 4 ESP Mods - Bid		13-May-13*	0
U1-A1010	Unit 1 - Bid		03-Sep-13*	0
U1-A1002	S&L Engineering / Design	29-May-12	03-Sep-13	322
U1-A1060	Common Bid Unit 1, 3, & 4 ESP Mods - Award		19-Sep-13	0
U1-A1004	S&L Procurement	29-May-12	13-Dec-13	393
U1-A1020	Unit 1 - Award		19-Dec-13	0
U1-A1030	ESP Component Farication	04-Feb-14	02-Jan-15	232
U1-A1040	ESP Updates Install	17-Oct-14	11-Mar-15	100
U1-A1080	ESP in Service		22-Apr-15	0
U1-A1000	Spring 2015 Outage - ESP Tie-In Outage	02-Mar-15*	24-Apr-15	40
U1-A1006	S&L Construction Support	19-Dec-13	24-Apr-15	343
U1-A1090	COD		20-May-15	0
U1-A1070	ESP Startup & Commissioning	12-Mar-15	04-Jun-15	60
Units 1, 2, 3, & 4 GWC		01-Jun-12	24-Apr-15	736
U1-A5010	Unit 1, 2, 3 & 4 GWC - Bid		04-Feb-13*	0
U1-A5020	Unit 1, 2, 3 & 4 GWC - Award		24-May-13	0
U1-A5070	Detailed Engineering to Support GWC Bids	01-Jun-12	24-May-13	250
U1-A5030	Unit 1 GWC Installation	19-Dec-13	24-Apr-15	343
ACI/DSI All Units		09-Jul-12	23-Dec-14	625
U1-A8000	ACI/DSI - Bid		09-Jul-12*	0
U1-A8110	CEMS - Bid		10-Sep-12*	0
U1-A8010	ACI/DSI - Award		29-Oct-12	0
U1-A8120	CEMS - Award		03-Jan-13	0
U1-A8020	ACI/DSI - Vendor Engr.	29-Nov-12	22-Feb-13	60
U1-A8130	CEMS - Vendor Engr.	01-Feb-13	25-Apr-13	60
U1-A8030	ACI/DSI - Fabrication & Delivery (1st Unit)	25-Feb-13	09-Oct-13	160
U1-A8050	Install ACI/DSI (Unit 1)	10-Oct-13	04-Mar-14	100
U1-A8040	ACI/DSI - Fabrication & Delivery (Remaining Units)	26-Sep-13	07-Aug-14	220
U1-A8140	Hg, FPM, HCl CEMS - Fabrication & Delivery	26-Apr-13	27-Aug-14	340
U1-A8100	ACI/DSI Testing	06-Mar-14	23-Dec-14	204



TASK filter: Report Filter.

Activity ID	Activity Name	Start	Finish	RD
IPL Petersburg U2 - LVL 1 Schedule		02-Jan-12 A	06-Apr-15	725
Petersburg Station		02-Jan-12 A	06-Apr-15	725
Unit 1		13-May-13	19-Sep-13	90
A1050	Common Bid Unit 1, 3, & 4 ESP Mods - Bid		13-May-13*	0
A1060	Common Bid Unit 1, 3, & 4 ESP Mods - Award		19-Sep-13	0
Unit 2		02-Jan-12 A	06-Apr-15	725
A2010	Unit 2 Baghouse Bid Evaluation	02-Jan-12 A	29-Jun-12	24
A2020	Receive Baghouse LNTP		29-Jun-12	0
A2030	Receive Baghouse FNTP		04-Mar-13	0
A2002	S&L Engineering / Design	02-Jan-12 A	13-May-13	244
A2004	S&L Procurement	02-Jan-12 A	18-Sep-13	333
A2000	Fall 2013 Outage - Booster Fans & Transformers	14-Oct-13*	13-Dec-13	43
A2070	Unit 2 Booster Fan Installation	24-Jul-13	13-Dec-13	100
A2040	Baghouse Fabrication and Delivery	05-Mar-13	03-Jul-14	340
A2050	Baghouse Baghouse Installation	10-Apr-14	23-Jan-15	200
A2060	Baghouse Startup & Commissioning	26-Dec-14	20-Mar-15	60
A2006	S&L Construction Support	28-May-13	02-Apr-15	470
A2001	Spring 2015 Tie-In Outage	02-Mar-15*	06-Apr-15	26
Units 2 & 3 Fans		29-May-12	15-Aug-13	310
A3010	Unit 2 & 3 Booster Fans - Bid		29-May-12	0
A3020	Unit 2 & 3 Booster Fans - Award		21-Aug-12	0
A3030	Unit 2 Fan Fabrication & Delivery	22-Aug-12	15-Aug-13	250
Units 2 & 3 Electrical		02-Jan-12 A	10-Oct-13	325
A4030	Unit 2 Aux Power Study	02-Jan-12 A	24-Feb-12 A	0
A4010	Unit 2 & 3 Aux Power Transformer- Bid		29-Jun-12	0
A4020	Unit 2 & 3 Aux Power Transformer- Award		16-Oct-12	0
A4040	Unit 2 Aux Power Transformer-Fabrication & Delivery	17-Oct-12	10-Oct-13	250
Units 1, 2, 3, & 4 GWC		01-Jun-12	02-Apr-15	720
A5010	Unit 1, 2, 3 & 4 GWC - Bid		04-Feb-13*	0
A5020	Unit 1, 2, 3 & 4 GWC - Award		24-May-13	0
A5070	Detailed Engineering to Support GWC Bids	01-Jun-12	24-May-13	250
A5040	Unit 2 GWC Installation	28-May-13	02-Apr-15	470
Unit 2 & 3 Structural Steel		01-Jun-12	17-Jul-14	540
A6010	Unit 2 & 3 Structural Steel - Bid		04-Feb-13*	0
A6020	Unit 2 & 3 Structural Steel- Award		24-May-13	0
A6070	Detailed Engineering to Support Steel & Ductwork Bids	01-Jun-12	24-May-13	250
A6030	Unit 2 Structural Steel Fabrication & Delivery	28-May-13	22-Apr-14	230
A6040	Unit 2 Steel & Duct Erection	03-Oct-13	17-Jul-14	200
ACI/DSI All Units		09-Jul-12	23-Dec-14	625
A8000	ACI/DSI - Bid		09-Jul-12*	0
A8110	CEMS - Bid		10-Sep-12*	0
A8010	ACI/DSI - Award		29-Oct-12	0
A8120	CEMS - Award		03-Jan-13	0
A8020	ACI/DSI - Vendor Engr.	29-Nov-12	22-Feb-13	60
A8130	CEMS - Vendor Engr.	01-Feb-13	25-Apr-13	60
A8030	ACI/DSI - Fabrication & Delivery (1st Unit)	25-Feb-13	09-Oct-13	160
A8060	Install ACI/DSI (Unit 2)	05-Mar-14	24-Jul-14	100
A8040	ACI/DSI - Fabrication & Delivery (Remaining Units)	26-Sep-13	07-Aug-14	220
A8140	Hg, FPM, HCl CEMS - Fabrication & Delivery	26-Apr-13	27-Aug-14	340
A8100	ACI/DSI Testing	06-Mar-14	23-Dec-14	204



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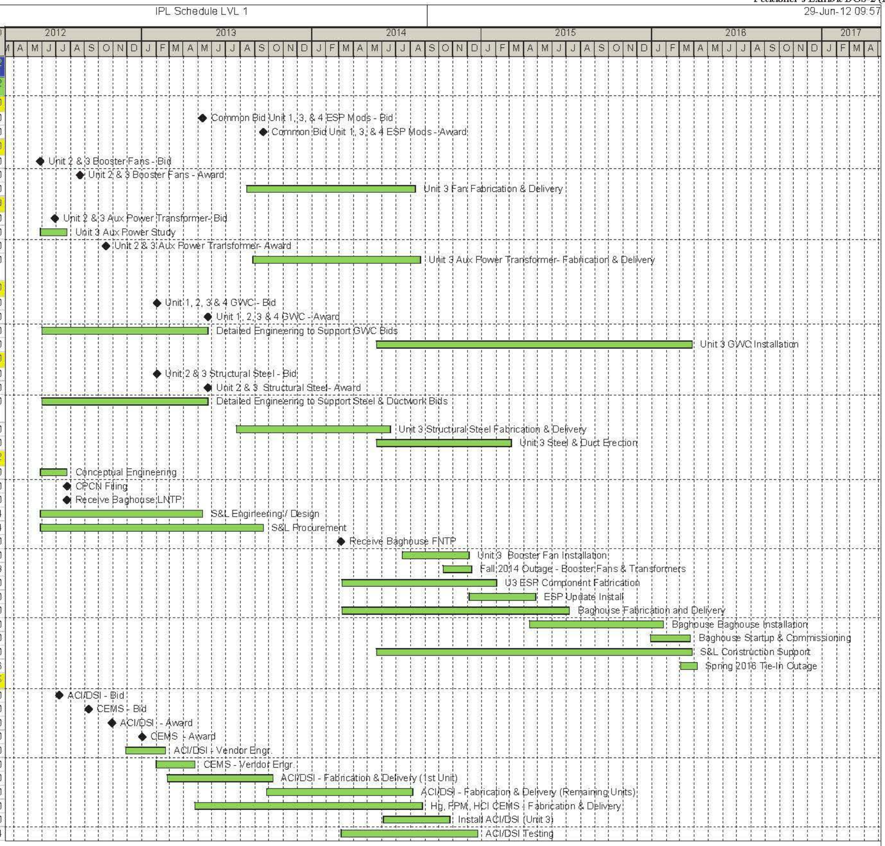
Activity ID	Activity Name	Start	Finish	RD
IPL Petersburg U3 - LVL 1 Schedule		29-May-12	08-Apr-16	982
Petersburg Station		29-May-12	08-Apr-16	982
Unit 1		13-May-13	19-Sep-13	90
A1050	Common Bid Unit 1, 3, & 4 ESP Mods - Bid		13-May-13*	0
A1060	Common Bid Unit 1, 3, & 4 ESP Mods - Award		19-Sep-13	0
Units 2 & 3 Fans		29-May-12	11-Aug-14	560
A3010	Unit 2 & 3 Booster Fans - Bid		29-May-12	0
A3020	Unit 2 & 3 Booster Fans - Award		21-Aug-12	0
A3040	Unit 3 Fan Fabrication & Delivery	16-Aug-13	11-Aug-14	250
Units 2 & 3 Electrical		29-May-12	22-Aug-14	569
A4010	Unit 2 & 3 Aux Power Transformer- Bid		29-Jun-12	0
A4050	Unit 3 Aux Power Study	29-May-12	24-Jul-12	40
A4020	Unit 2 & 3 Aux Power Transformer- Award		16-Oct-12	0
A4060	Unit 3 Aux Power Transformer- Fabrication & Delivery	29-Aug-13	22-Aug-14	250
Units 1, 2, 3, & 4 GWC		01-Jun-12	28-Mar-16	970
A5010	Unit 1, 2, 3 & 4 GWC - Bid		04-Feb-13*	0
A5020	Unit 1, 2, 3 & 4 GWC - Award		24-May-13	0
A5070	Detailed Engineering to Support GWC Bids	01-Jun-12	24-May-13	250
A5050	Unit 3 GWC Installation	21-May-14	28-Mar-16	470
Unit 2 & 3 Structural Steel		01-Jun-12	05-Mar-15	700
A6010	Unit 2 & 3 Structural Steel - Bid		04-Feb-13*	0
A6020	Unit 2 & 3 Structural Steel- Award		24-May-13	0
A6070	Detailed Engineering to Support Steel & Ductwork Bids	01-Jun-12	24-May-13	250
A6050	Unit 3 Structural Steel Fabrication & Delivery	24-Jul-13	18-Jun-14	230
A6060	Unit 3 Steel & Duct Erection	21-May-14	05-Mar-15	200
Unit 3		29-May-12	08-Apr-16	982
A7010	Conceptual Engineering	29-May-12	24-Jul-12	40
A7020	CPCN Filing		24-Jul-12	0
A7025	Receive Baghouse LNTP		24-Jul-12	0
A7002	S&L Engineering / Design	29-May-12	13-May-13	244
A7004	S&L Procurement	29-May-12	19-Sep-13	334
A7030	Receive Baghouse FNTP		06-Mar-14	0
A7070	Unit 3 Booster Fan Installation	15-Jul-14	04-Dec-14	100
A7000	Fall 2014 Outage - Booster Fans & Transformers	10-Oct-14*	11-Dec-14	43
A7080	U3 ESP Component Fabrication	07-Mar-14*	02-Feb-15	230
A7090	ESP Update Install	05-Dec-14	27-Apr-15	100
A7040	Baghouse Fabrication and Delivery	07-Mar-14	08-Jul-15	340
A7050	Baghouse Baghouse Installation	14-Apr-15	27-Jan-16	200
A7060	Baghouse Startup & Commissioning	30-Dec-15	23-Mar-16	60
A7006	S&L Construction Support	21-May-14	28-Mar-16	470
A7001	Spring 2016 Tie-In Outage	04-Mar-16*	08-Apr-16	26
ACI/DSI All Units		09-Jul-12	23-Dec-14	625
A8000	ACI/DSI - Bid		09-Jul-12*	0
A8110	CEMS - Bid		10-Sep-12*	0
A8010	ACI/DSI - Award		29-Oct-12	0
A8120	CEMS - Award		03-Jan-13	0
A8020	ACI/DSI - Vendor Engr.	29-Nov-12	22-Feb-13	60
A8130	CEMS - Vendor Engr.	01-Feb-13	25-Apr-13	60
A8030	ACI/DSI - Fabrication & Delivery (1st Unit)	25-Feb-13	09-Oct-13	160
A8040	ACI/DSI - Fabrication & Delivery (Remaining Units)	26-Sep-13	07-Aug-14	220
A8140	Hg, FPM, HCl CEMS - Fabrication & Delivery	26-Apr-13	27-Aug-14	340
A8080	Install ACI/DSI (Unit 3)	05-Jun-14	24-Oct-14	100
A8100	ACI/DSI Testing	06-Mar-14	23-Dec-14	204



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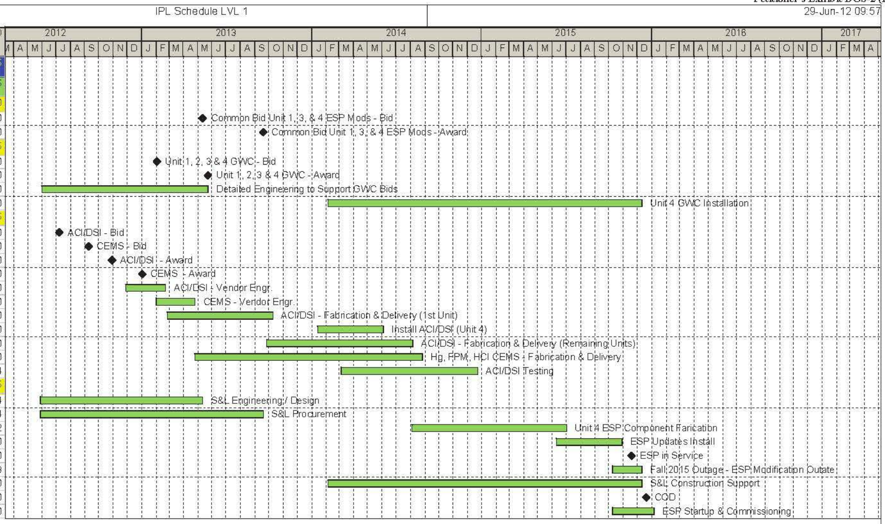
IPL Schedule LVL 1

29-Jun-12 09:57

Activity ID	Activity Name	Start	Finish	RD
IPL Petersburg U4 - LVL 1 Schedule		29-May-12	06-Jan-16	915
Petersburg Station		29-May-12	06-Jan-16	915
Unit 1		13-May-13	19-Sep-13	90
A1050	Common Bid Unit 1, 3, & 4 ESP Mods - Bid		13-May-13*	0
A1060	Common Bid Unit 1, 3, & 4 ESP Mods - Award		19-Sep-13	0
Units 1, 2, 3, & 4 GWC		01-Jun-12	10-Dec-15	895
A5010	Unit 1, 2, 3 & 4 GWC - Bid		04-Feb-13*	0
A5020	Unit 1, 2, 3 & 4 GWC - Award		24-May-13	0
A5070	Detailed Engineering to Support GWC Bids	01-Jun-12	24-May-13	250
A5060	Unit 4 GWC Installation	05-Feb-14	10-Dec-15	470
ACI/DSI All Units		09-Jul-12	23-Dec-14	625
A8000	ACI/DSI - Bid		09-Jul-12*	0
A8110	CEMS - Bid		10-Sep-12*	0
A8010	ACI/DSI - Award		29-Oct-12	0
A8120	CEMS - Award		03-Jan-13	0
A8020	ACI/DSI - Vendor Engr.	29-Nov-12	22-Feb-13	60
A8130	CEMS - Vendor Engr.	01-Feb-13	25-Apr-13	60
A8030	ACI/DSI - Fabrication & Delivery (1st Unit)	25-Feb-13	09-Oct-13	160
A8070	Install ACI/DSI (Unit 4)	15-Jan-14	04-Jun-14	100
A8040	ACI/DSI - Fabrication & Delivery (Remaining Units)	26-Sep-13	07-Aug-14	220
A8140	Hg, FPM, HCl CEMS - Fabrication & Delivery	26-Apr-13	27-Aug-14	340
A8100	ACI/DSI Testing	06-Mar-14	23-Dec-14	204
Unit 4		29-May-12	06-Jan-16	915
A9002	S&L Engineering / Design	29-May-12	13-May-13	244
A9004	S&L Procurement	29-May-12	19-Sep-13	334
A9030	Unit 4 ESP Component Farication	05-Aug-14*	02-Jul-15	232
A9040	ESP Updates Install	10-Jun-15	29-Oct-15	100
A9060	ESP in Service		19-Nov-15	0
A9000	Fall 2015 Outage - ESP Modification Outate	09-Oct-15*	10-Dec-15	43
A9006	S&L Construction Support	05-Feb-14	10-Dec-15	470
A9070	COD		21-Dec-15	0
A9050	ESP Startup & Commissioning	09-Oct-15	06-Jan-16	60



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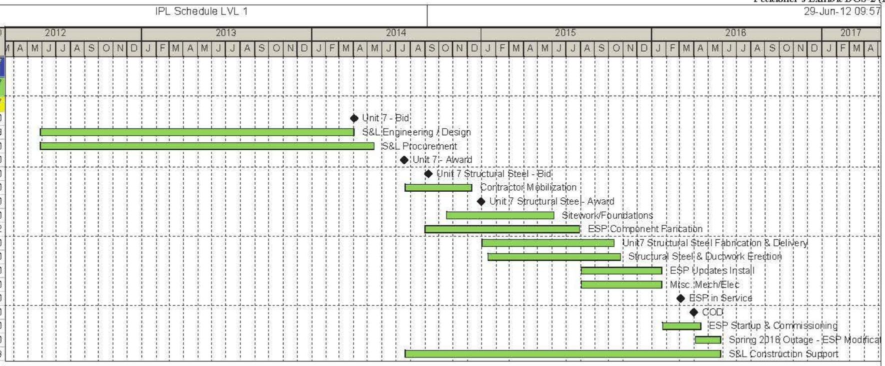
IPL Schedule LVL 1

29-Jun-12 09:57

Activity ID	Activity Name	Start	Finish	RD
IPL Harding Street - LVL 1 Schedule		29-May-12	27-May-16	1017
Harding Street Station		29-May-12	27-May-16	1017
Unit 7		29-May-12	27-May-16	1017
B1010	Unit 7 - Bid		02-Apr-14*	0
B1002	S&L Engineering / Design	29-May-12	02-Apr-14	469
B1004	S&L Procurement	29-May-12	15-May-14	500
B1020	Unit 7 - Award		18-Jul-14	0
B1040	Unit 7 Structural Steel - Bid		08-Sep-14*	0
B1070	Contractor Mobilization	21-Jul-14	10-Dec-14	100
B1050	Unit 7 Structural Steel- Award		31-Dec-14	0
B1080	Sitework/Foundations	17-Oct-14	04-Jun-15	160
B1030	ESP Component Farication	02-Sep-14	30-Jul-15	232
B1060	Unit7 Structural Steel Fabrication & Delivery	02-Jan-15	13-Oct-15	200
B1090	Structural Steel & Ductwork Erection	15-Jan-15	26-Oct-15	200
B1100	ESP Updates Install	03-Aug-15	22-Jan-16	120
B1110	Misc. Mech/Elec	03-Aug-15	22-Jan-16	120
B1130	ESP in Service		04-Mar-16	0
B1140	COD		01-Apr-16	0
B1120	ESP Startup & Commissioning	25-Jan-16	15-Apr-16	60
B1000	Spring 2016 Outage - ESP Modification Outage	04-Apr-16*	27-May-16	40
B1006	S&L Construction Support	21-Jul-14	27-May-16	473



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APPENDIX H.
2012 TESTING PROTOCOL

Harding Street Unit 7 and Petersburg Unit 2

TESTING PROTOCOL—MATS COMPLIANCE EVALUATION

SL-010910
Draft
Revision 5

March 20, 2012
Project 10572-060

Prepared by

Sargent & Lundy LLC

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